THE

ENGINEERING MAGAZINE

VOL. IV. NOVEMBER, 1892. NO. 2.

LIGHT IN TALL OFFICE BUILDINGS.

By Dankmar Adler.

IN a preceding article in this Magazine I stated that the tall office building represents the working out of one of the dominant tendencies in the development of the human race and endeavored to indicate dangers incident to possible misapplication and misdirection of this tendency. It is the purpose of this article to point out some of the difficulties incident to the problem of erecting high buildings of this type, and to endeavor to indicate means of avoiding them.

Those who have taken a serious interest in this subject have devoted themselves almost entirely to the structural difficulties incident to the problem. I must confess that I cannot agree with those who place the matter of structural design as first in importance. I can easily imagine a tall office building most admirable in everything that relates to mere construction, and yet worthless to its owners. My advocacy of the necessity for tall buildings does not carry me to the extent of maintaining that the mere carrying up of a building to great altitude is something meritorious. A building of this type should be erected only when accommodation is required for the carrying on of business in health and in comfort to a greater number of occupants than can be accommodated by other means.

The first requisite to the successful occupation of any premises for use as offices by professional and business men is light and air. The earlier "sky-scrapers" commended themselves to the public because, towering to a great height among comparatively low buildings, they exposed great window-areas to the light. With the

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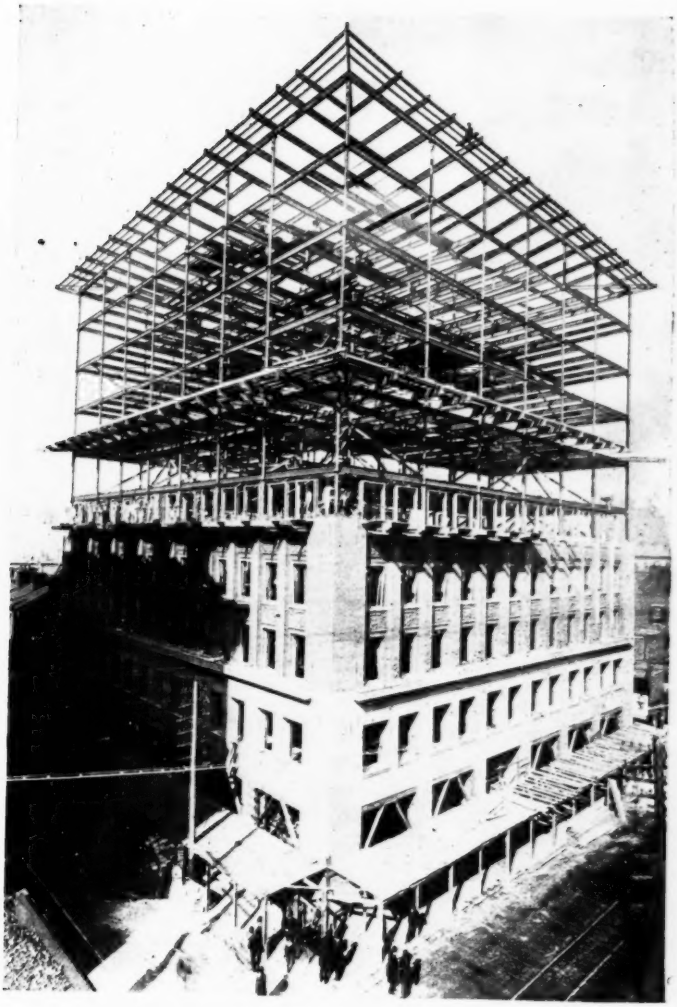
multiplication of these structures we begin to lose this particular advantage, for the attainment of which high buildings are chiefly projected, and for which their earlier prototypes were noted. It seems that the erection of one "sky-scraper" implies the erection of many, and that these buildings apparently emulate the trees of the forest in the attempts of each to enjoy more of the sunshine than its neighbors; it therefore becomes necessary to so regulate this emulation as to assure access of light and air not only to the housetops, but also to permit the sun and air to permeate to the streets and into the rooms of the lower stories. But the process of permanently assuring the necessary supply of light and air to the interior of high buildings is difficult of accomplishment. High realty values are characteristics of the neighborhoods in which buildings of this type are erected. To give up large areas of this valuable ground, multiplied by the number of stories of the proposed building, seems a great sacrifice, which to ordinary human nature becomes still greater when it is considered that frequently the most efficient means of gaining the desired end consists in giving up ground for sources of light and air so that neighboring owners, or the general public, will also derive benefit therefrom.

I shall try here to show the necessity for giving up large areas for use as sources of light to the interior of tall office buildings.

The experience of real-estate agents shows that high rentals can be obtained only for well-lighted offices, and that the most desirable tenants will not occupy inferior or ill-lighted rooms at ever so low a rental. Their experience further shows that tenants of high professional and business standing draw into the building which they occupy others of like character, and that occupation of premises by tenants of inferior standing in the community repels tenants of the higher grade. If, therefore, a given building, no matter how favorably located, how soundly constructed, and how well equipped, has many dark rooms, it cannot be rented at all; or, if rented, its tenants will be undesirable in character and standing, and the rental derived from the investment will be small. But while the rents are small, operating expenses will be large; interest charges and taxes, operation and maintenance of elevator-service and heating apparatus, will be as great as though the building were filled with tenants paying the highest rent. The amount expended for artificial light will be much greater than if the building were properly planned; and even the cost of repairs will increase, because infe-



THE WAINWRIGHT BUILDING, ST. LOUIS.

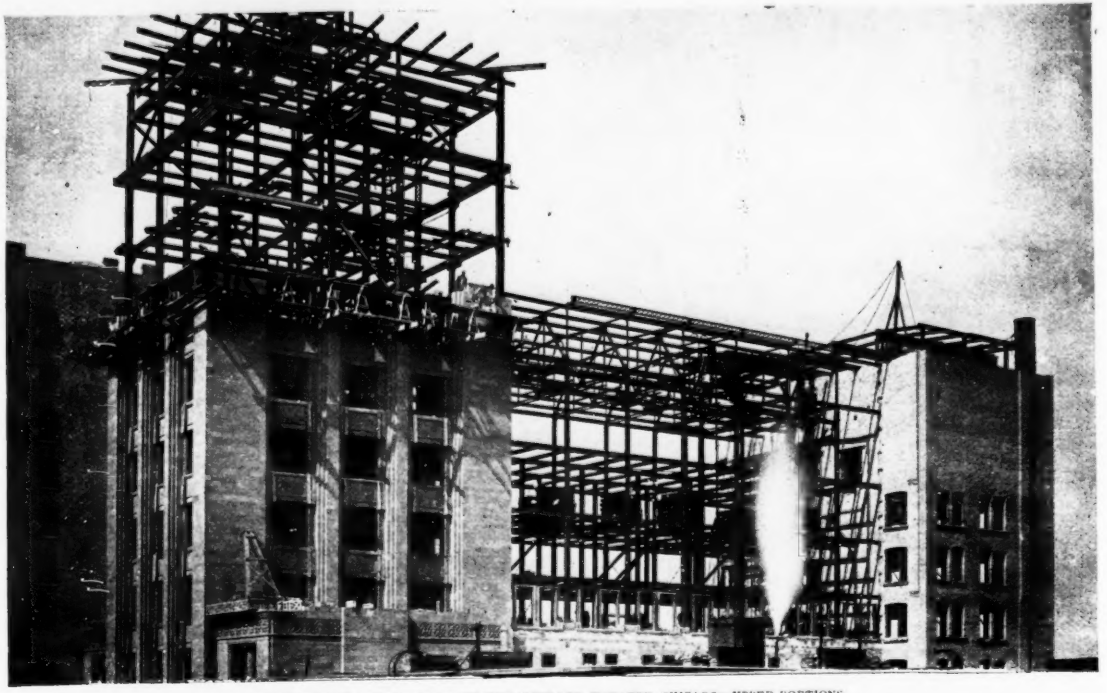
rior tenants will not take as good care of their premises as will a better grade. The result will be rapid depreciation in the value of the securities representing the ownership of the building, and the possible complete elimination of many, and finally a process of liquidation, which, owing to the large investments in these buildings, will affect seriously the financial interests of the community.

And yet, as one tall building continues to crowd upon another, how shall the window-area covered and obscured by their shadows be kept within reasonable bounds, and the evils before designated be avoided? The first answer, and the one that is ordinarily made by those who endeavor to correct every evil under the sun by legal enactment, is to limit by municipal legislation the height to which structures of this type may be erected. This is at best but a partial remedy. No matter what the limitation of height as fixed by municipal ordinances, it is possible to erect buildings of which the greater part of the interior is dark and therefore of comparatively little value. Probably every reader has in mind structures limited in height which contain but few well-lighted rooms. Many will remember the uninteresting sameness of sky-line in the street architecture of cities which have tried such a policy.

A far more efficient means of controlling the construction of tall buildings, and of preserving public interests that might be affected by errors in their design, could be established by the intelligent development of public opinion among investors, bankers, and so on. In Chicago, for instance, almost all buildings of this type have been erected by stock companies organized for that especial purpose, and the means for their erection have been procured partly by stock subscription and partly by sale of bonds. If investors, before purchasing these securities,—or bankers, before receiving them as collateral,—will inquire as to the extent to which attention has been paid in their planning, not merely to the immediate supply of light, but also to the probable condition of these buildings when other tall structures shall have been erected in their neighborhood, regulating their attitude by the result of their investigation, it will become impossible to carry out any plan for the erection of a "sky-scraper" without due provision for light and air.

The closest study of this problem will show that no general rule can be laid down as to a limit of height, and no general law establishing a definite ratio of area of building to dimensions of light-giving space. Each case must be judged on its own merits.

Experience has shown that only under quite unusual conditions



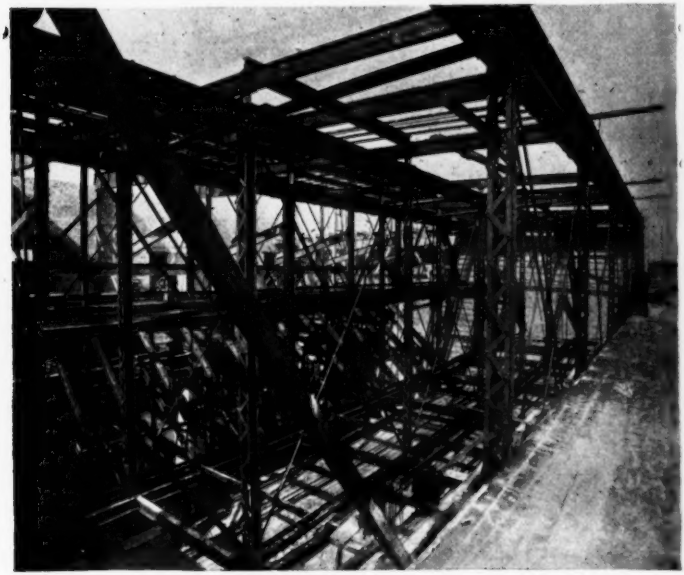
STEEL-FRAME CONSTRUCTION OF THE SCHILLER THEATER, CHICAGO—UPPER PORTIONS.

is it possible to carry a sufficient volume of daylight for purposes of reading and writing—as found necessary in the transaction of ordinary office business—to a greater distance than twenty-five feet from the source of light. There are many cases where this limit is twenty feet or less. Taking these figures as the basis of our calculation, it would appear that a building having light from front and rear, and two tiers of offices, one to the front and one to the rear, should not be made deeper under any circumstances, after making due allowances for halls, corridors, and partitions, than about

AUDITORIUM ROOF TRUSSES—CHICAGO.

sixty-five feet, and that there may be instances where this depth could be very advantageously reduced to even less than forty feet. As the measure of strength of any piece of construction is that of its weakest part, so to a great extent is the character of a building determined by that of its least desirable portions. A number of poorly-lighted rooms occupied by undesirable tenants will do more toward driving good tenants from a building than will be accomplished as a matter of attraction by an equal number of tenants of a high grade. In planning a building, therefore, no matter how

much space there may be, the distance from outside wall to outside wall should not be too great for the satisfactory lighting of the interior. Again, there should be an endeavor to have the inside rooms as well lighted as the rooms which obtain light from the street. This can be done only by approximating as nearly as possible in the dimensions of internal light-courts the width of the street on which the building fronts. In many instances it will be found advisable, in the design of light-courts, to face them externally, and



AUDITORIUM ROOF TRUSSES—CHICAGO.

make them in a certain sense an enlargement of the street. By this means the efficiency of the source of light is very materially increased, because its horizon is enlarged by a distance equal to the width of the street ; and, on the other hand, the efficiency of the street as a general source of light and air is materially enhanced.

In many instances, particularly in the case of properties of comparatively narrow street-frontage, but of considerable depth, it will be found advantageous to make arrangements with the owners of neighboring properties by which large courts are made for the joint

AUDITORIUM ROOF TRUSSES—CHICAGO.

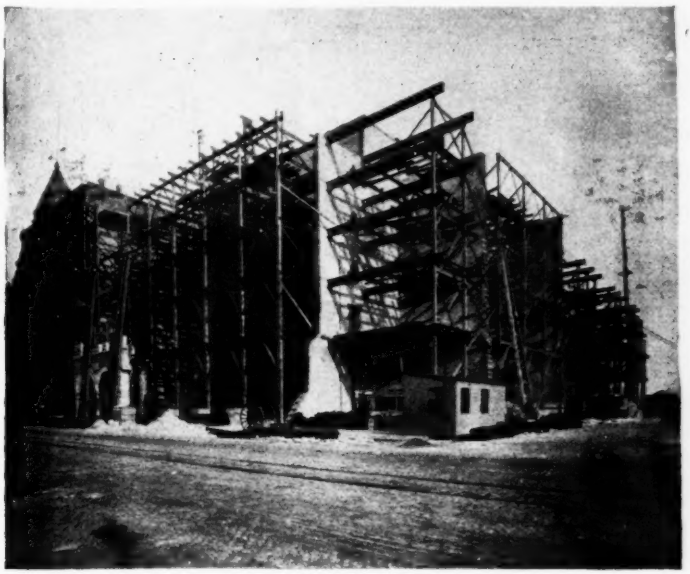
use of the different properties; and even when it is impossible to effect such arrangements, it may be advisable to provide a court facing upon the property of a neighbor in the expectation that a realization on his part of his best interests will cause him to enlarge this court for his own advantage. In all cases, however, the advantage is with the property-owner who controls the largest ground-area. The larger the base-area of the building, the greater may be its height as regards its stability; the more efficient its elevator service can be made, the greater the freedom allowable in devising sufficient light-courts.

With the expansion of buildings upward into the air will come, as the problem becomes better understood, a greater tendency toward a corresponding enlargement of the areas of individual building sites. The owner of a small piece of ground is at a greater disadvantage as the necessity for increased height of buildings becomes more pronounced. Efficient and continued elevator-service can be much more readily guaranteed with a large number of small elevators than with a large one; yet to increase the number of ele-

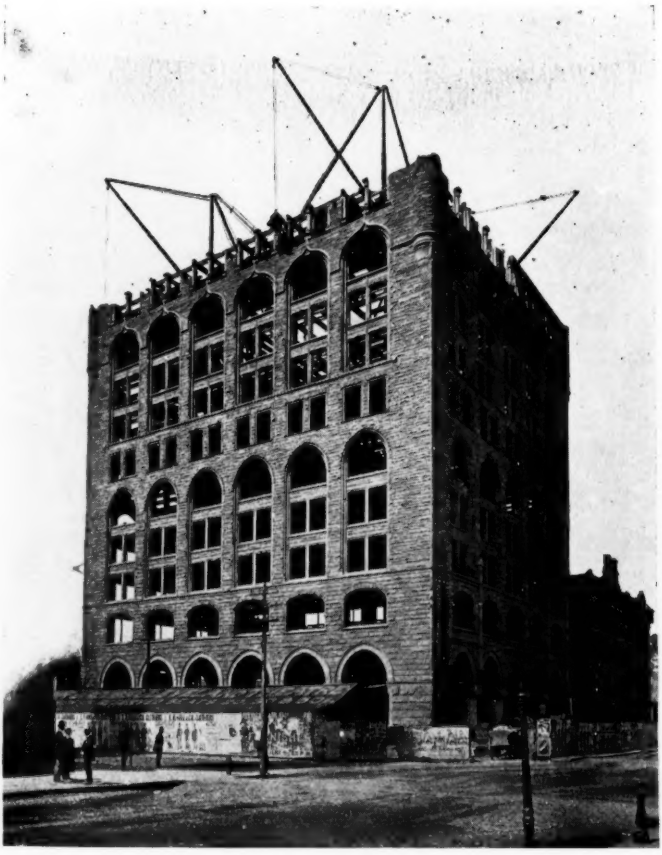
vators in a building may absorb so great a portion of its area that sufficient floor-room may not be left for offices to be served by the elevators. Light-courts, whether internal or external, will absorb relatively a much greater proportion of the area of a small property than of a large one ; so that we shall see in the future an absorption of the small holdings of realty by individuals and corporations whose purpose is to erect tall business buildings. Nor need the owner of a small piece of realty fare badly in consequence of this. The possibility of erecting "sky-scrapers" in a given neighborhood will increase real estate values to a far greater extent than could be attained if the height of its buildings were limited by the areas of the smaller real estate holdings, and will enable the owner to sell at a greater price than if the tall buildings were an impossibility.

Accompanying this article are typical floor-plans from a number of existing office buildings, in which the reader will see illustrations of various methods of construction that have been found successful in actual practice.

Plan No. 1 is that of a building originally designed to be seven stories high. It has now for a next-door neighbor a seventeen-



AUDITORIUM—SOUTHWEST CORNER.



SOCIETY FOR SAVINGS BUILDING, CLEVELAND.

story "sky-scraper." The court of building No. 1 would have been altogether too small if the owners of the adjacent building had not also constructed a court which practically doubles the area of the court of the older building; but still I believe that if this building had been at first ten or more stories high, it would have been wise to have reduced the depth of its rooms, and to have increased the area of its court.

Plan No. 2 is that of a building fourteen stories in height, in

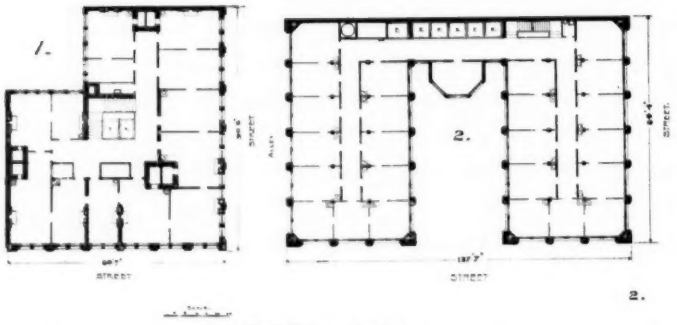
which there is an external court opening upon the street. The two streets upon which this building faces are each seventy feet wide.

In No. 3 there is an internal court, which opens upon an alley. For the purpose of gaining better light for the rooms facing upon the alley, to the left of this building a break has been introduced in the wall so as to insure permanence of light for the comparatively shallow rooms.

In No. 4 an area equal to ten per cent. of the entire surface of the lot has been given up as a source of light. The alleys in this case are formed, for the most part, by the dedication of ground by the owners of neighboring properties.

Plan No. 5 is a four-corner building with an internal light-court, with regard to the enlargement of which no arrangement

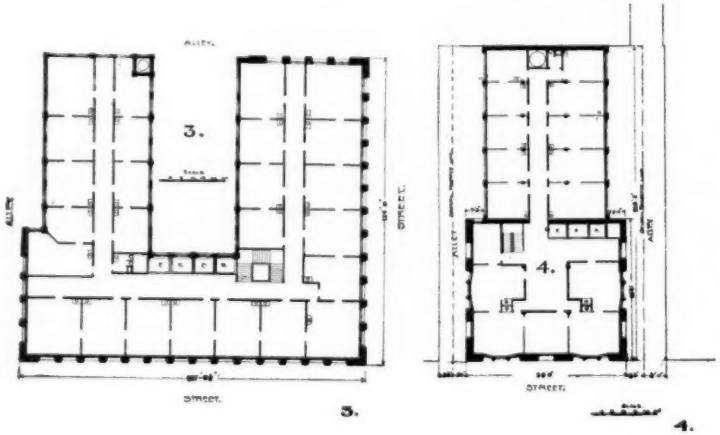
EQUITABLE BUILDING, ATLANTA.



PLANS NO. 1 AND NO. 2.

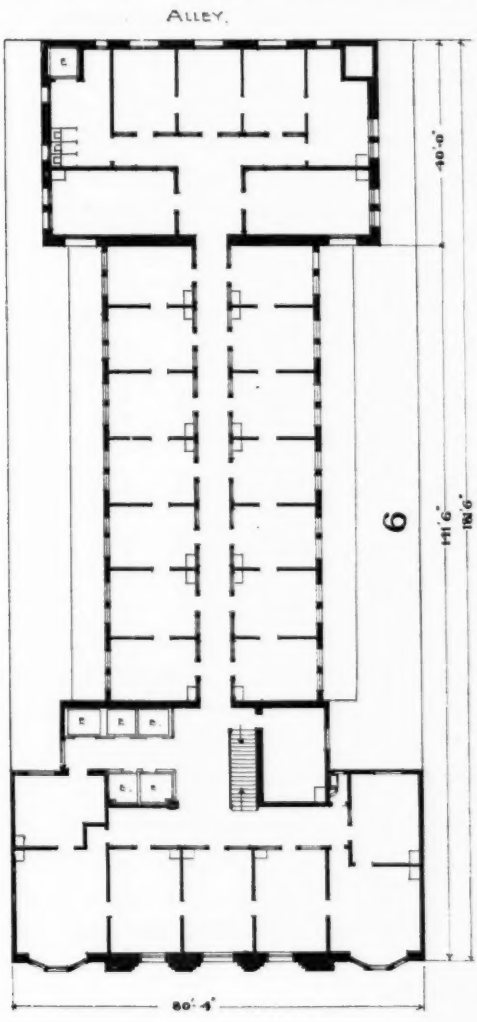
has been made with the owners of neighboring properties ; but the conditions of those properties are such that it would be suicidal for their owners to erect a building ignoring the light-court of No. 5.

No. 6 is a building on an inside lot, in the case of which light has been secured by narrowing the central part of the upper stories of the building, forming two external courts so situated with regard to neighboring properties that the owners of these will probably find themselves compelled to join in the enlargements of the courts of No. 6. A block-plan showing the relative positions of No. 1, No. 6, and No. 5, which happen to occupy the positions shown



PLANS NO. 3 AND NO. 4.

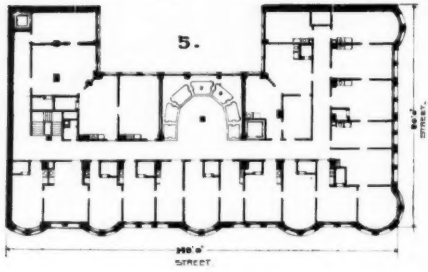
them, will show that my assumptions before stated are probably correct. In the case of No. 6 it will be interesting to note that of the front of the building only the central part is carried up to the full height, while the two lateral wings, with the bay windows, are carried up but part way, leaving a tower-like effect for the remainder of the building; and also, as the building fronts south, admitting a greater volume of light into the side courts than would be the case had the full building been carried to full height.



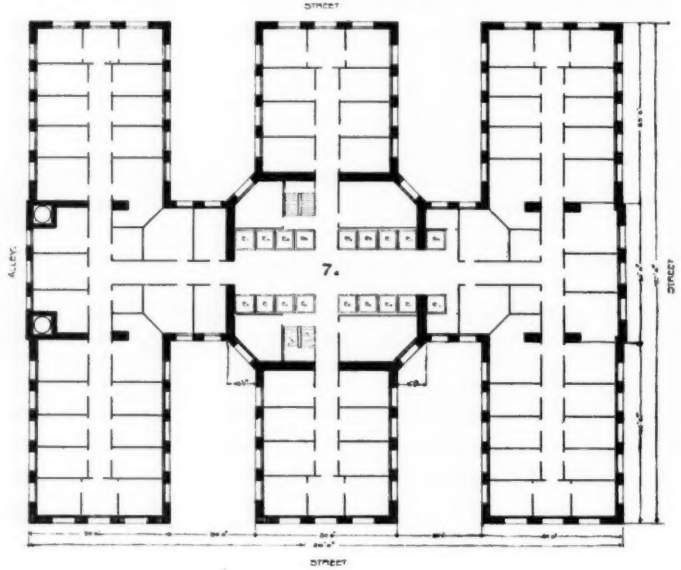
PLAN NO. 6.

No. 7 is the plan of a proposed building which has not been erected. This shows what can be accomplished in the way of "sky-scraper" construction upon a very large building-site. In this case there were two streets, one

narrow alley, and one wide alley. It was proposed to give up enough space to make the two alleys the equivalent of streets in width, and then to construct the building for a height of ten stories. At the tenth story it was intended to stop the wings *A*, *B*, *C*, and *D*, and to carry up the remainder of the building, which would then be cruciform, to a height of ten stories or more, while the central portion of the building was to have formed a tower standing about twelve stories above the topping out of the rooms of the cross. The effect of this would have been exceedingly picturesque; here would have been abundant light in every portion of the building; and by reason of the large external courts, and the great dis-



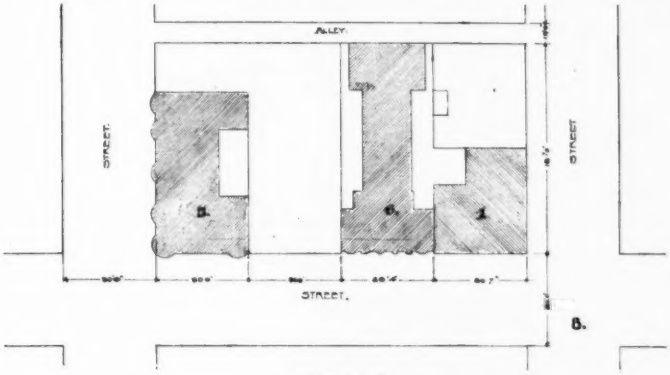
PLAN NO. 5.



PLAN NO. 7.

tance of the parts carried up to the greater height, disturbing shadows upon the streets or upon buildings on the opposite side thereof would have been avoided. An infinite number of variations in the application of this principle can be made in the planning of very tall buildings upon large sites, and this is a fit subject for the study of owners and their architects. It may be made the subject of a future article in these pages.

In laying down the general theory that, unless sufficient light is secured for all time for the interior of a tall office building, it will become almost a public nuisance, I base my judgment upon observation of actual occurrences. I remember three buildings, two erected by myself, and the other by another architect, all for one



PLAN No. 8.

client. He considered the proposition that the area of his buildings should be reduced for the purpose of gaining large light-courts as exceedingly unbusinesslike, and as a most improvident waste of valuable realty, and treated the possibility that his neighbors might profit by his generosity to himself as something akin to communism, and therefore highly reprehensible. This person was a banker and had invested a large portion of his own and other people's money in these particular buildings. They were dark; it was impossible to rent them; and they formed an important factor in his eventual financial ruin, and the utter collapse of the institutions with which he was connected. All of these buildings have passed into other hands; two have since been remodeled and provided with large light-courts, and have become profitable investments. The third is held by persons as narrow-minded as the orig-

inal owner, and no change has been made. The result is that it is to a great extent unoccupied, and the parts which are rented bring but a very small income. Another instance is that of a building erected in Chicago by a speculator and sold to a rich corporation. It abutted upon a narrow alley, on the opposite side of which a "sky-scraper" was erected. The result was the necessity for completely reconstructing the interior of the first building and providing it with a large light-court.

There is—I will not say where—a building among the most notable of all "sky-scrapers" ever erected. A very large sum of money has been invested in the ground and building. Its projectors were unwilling to give up any of their realty for lighting purposes; in fact, they even went further, and all around their building projected bay-windows into the surrounding streets and alleys. The result is that they have offices from thirty-five to forty feet deep, of which only those in the very uppermost stories are well lighted; and notwithstanding their building is situated on one of the best business sites in the United States, it has thus far failed to rent, and bids fair to remain an unprofitable investment. Instances of this kind could be multiplied indefinitely.

While I have here treated of the proper lighting of buildings as of the first importance, I do not mean to have it understood that I consider the proper placing and proportioning of elevators, halls, corridors, and stairs, as of no importance. These items alone might well form the subject of an independent paper, which could be made as interesting as that of Mr. Carrère upon fire-protection, and so on. As regards construction also, while that subject has been very extensively treated in the columns of this Magazine by Mr. Goetz, there is still much to be said which may well be left to other articles by other authors. Finally, the artistic expression of structures, so entirely unknown to those upon whose work the grammar of modern architecture is based, should be treated in future papers. It seems, indeed, as if the "sky-scraper" presented phases that would require an independent literature for adequate treatment.

INDUSTRIAL DEVELOPMENT OF THE SOUTH.

By Richard H. Edmonds.

II.—FROM PROSPERITY TO POVERTY.

IN the early part of this century the South promised to become the industrial center of the country, but the growth of slavery exerted a depressing effect upon the manufacturing spirit, and gradually the artisan came to be regarded as inferior to the planter and the professional man. The planting of cotton, cane, and rice became not only the most profitable business, but the most highly esteemed. With the increase in the number of slaves the sentiment of this section grew in favor of large plantations on which the slaves could be controlled and worked in great numbers, which rendered urban development less rapid than in the North. Under these conditions the South for many years gave less and less attention to mechanical pursuits, permitting itself to be left behind, in this regard, by New England, though it developed a most wonderful agricultural prosperity. But even then a considerable number of Southern people gave their attention to a diversity of industries, and for some years before the war there was a very decided revival in many branches of manufacturing, which, but for the unfortunate struggle of 1860–65, might have resulted in the gradual building up of great industrial interests.

The facts and figures presented in the first article of this series, however, make a very much more creditable showing for the ante-bellum South in the way of railroad and industrial activity than the world has been inclined to give it credit for. They show that in some lines of industrial progress, such as railroad-building, for instance, the Southern States were outstripping the rest of the country in the rate of growth. And yet the agricultural interests of the South so largely predominated over all others that this section was usually regarded as almost wholly an agricultural country. When Eli Whitney gave the cotton-gin to the world, he opened up to the South probably the most dazzling prospects for unlimited wealth that any country has ever had before it. The potential in cotton cultivation, with slave labor and at such prices as this staple commanded from 1800 to 1860,—except for a few years between 1840 and 1850,—naturally turned the whole atten-

tion of the South to planting. The financial inducements in this industry far surpassed what could be hoped for in manufacturing, and cotton-planting gradually became the one absorbing business of the South, furnishing an inviting field for the capital and energy of the whole section. It was under such circumstances, when everything in that section tended to develop agriculture at the expense of industrial interests,—and despite the fact that capital and energy always seek the business which yields the best returns,—that the South made the industrial and railroad progress already recorded. Moreover, slavery *per se* is opposed to industrial growth. A slave-owning country cannot, except under most extraordinary circumstances, develop into a manufacturing country. But even this disadvantage, added to the large profits in cotton cultivation, resulting at times in overproduction, could not eradicate from many of the Southern people the tendency to industrial matters inherited from their sturdy ancestors, who had scarcely landed in Virginia and the Carolinas before they commenced to write to England about the iron ore found in such abundance, and who had soon built furnaces and bloomeries over the whole mountain region of the South.

The figures already presented show what industrial growth the South was making prior to 1860. Its advancement in other directions also merits attention, for these papers are designed to show that the South of olden times was a progressive country of great wealth and enterprise ; that its losses by the war were so incomprehensibly heavy as to make any return of prosperity impossible for many years ; that its general development during the last ten years, under all circumstances, has been phenomenally large, and that no other country in the world has so bright a future. Nowhere else can be found combined to the same extent the advantages and resources which insure beyond question the highest degree of activity and prosperity. All of the statistics given to support the statements regarding the condition of the South in 1860 are gathered from the United States Census reports. This is mentioned that there may be no doubt as to the credibility of these figures.

Promising as was the industrial advance of the South prior to the war, it was in its agriculture that the chief interests of the people were centered. Here was displayed an energy as great as that which opened up to civilization the vast prairies of the West ; here was a well-rounded growth which neither the South nor any other

part of the country has been able to duplicate since the war. Cotton was indeed King, but it was not such an absolute monarch as it has been since 1865, nor as grain has been in the West. Instead of being the main crop of the South, it was largely a surplus crop. The South did not then have its "smoke-house and corn-crib in the West,"—this was one of the disasters of the war,—but it produced its own corn, wheat, and bacon. The war changed these conditions. It left such universal poverty that men were compelled to grow cotton alone, because the crop could be mortgaged before it was planted for enough at least to secure a bare living for the planter while he waited for it to mature. On no other crop could advances be secured in this way. When the crop had been gathered and turned over to the merchant who had been "carrying" him, and out of its proceeds the debt for goods bought on credit—including interest and commissions—had been paid, the farmer had nothing left. As the next season came around he was again compelled to mortgage his crop in advance to the man to whom he was already in debt. It was "a condition and not a theory" that confronted the farmers of the South, and necessarily it has taken years for them to gradually work out of it. Moreover, the negroes, "intoxicated with freedom," had many hard lessons to learn. While they had nothing in the world on which to start, they were financially about as well off as their late masters, for at least they had no debts to encumber them for years to come. Cotton was the easiest crop for them to cultivate, and so they all began to grow cotton, buying Western corn and bacon on credit from the merchant who had a mortgage on their cotton before the ground was plowed for its planting. Working on shares,—that is, paying a part of the crop for the rent of the land they cultivated,—and constantly moving from place to place, they had no inducement to try to improve the soil. So while the aggregate acreage annually increased, the total production of the South's crops fell far short of the yield *per capita* between 1850 and 1860.

The simple truth is that the South, bankrupted by the war, was for the next ten or fifteen years engaged in doing an unprofitable business. The volume of its trade was large, but there was little or no profit in it. Studied in the light of the present, the Census reports are a revelation. To understand the full meaning of these reports of 1850 and 1860 it should be remembered that the total population of the country in 1860 was 31,000,000, of which the South had 6,800,000 whites and 4,100,000 negroes, or an aggregate of

10,900,000, about one-third of the country's population. With one-third of the aggregate population and only one-fourth of the white population, the South's agricultural products compared with the crops of the rest of the country as follows:

Crops in 1860.	Yield in South.	Yield in remainder of the country.
Corn, bushels	358,153,000	472,297,000
Wheat, bushels	44,800,000	125,200,000
Cotton, bales	5,196,000	None.
Tobacco, pounds	351,500,000	77,800,000
Rice, pounds	187,100,000	None.
Sweet potatoes, bushels	38,000,000	3,600,000
Sugar, pounds	604,000,000	None.

It might be supposed that growing the entire cotton crop of 5,196,000 bales, the rice crop of 187,000,000 pounds, and the sugar crop of 604,000,000 pounds, would have fully employed the farmers of the South, but to these they added 358,000,000 bushels of corn,—or 44 per cent. of the entire corn crop of the country,—nearly 45,000,000 bushels of wheat, and 38,000,000 bushels of sweet potatoes. Of smaller crops, fruits, vegetables, butter, etc., the South also produced its full proportion.

In 1860 the South had $95,000,000, out of a total of $246,000,000 in the whole country, invested in agricultural implements, or nearly 40 per cent., though it had only 33 per cent. of the population. The increase in the value of its agricultural implements from 1850 to 1860 was nearly $35,000,000, or 35 per cent.

The South's aggregate banking capital in 1860 was $117,400,000, or nearly 30 per cent. of the entire banking capital of the country. Better even than these figures, to prove that the South was a country of great progress and not slothful in the business of money-making, are the reports showing the assessed valuation and the estimated true valuation of property in the country in 1860. In that year the assessed value of property in Georgia was greater than the combined values of Maine, New Hampshire, Vermont, and Rhode Island. South Carolina was $68,000,000 richer than Rhode Island and New Jersey combined. Mississippi outranked Connecticut by $160,000,000. In the assessed value of property *per capita*, Connecticut stood first in rank; Rhode Island, second; South Carolina, third; Mississippi, fourth; Massachusetts, fifth;

Louisiana, sixth ; Georgia, seventh ; District of Columbia, eighth ; Florida, ninth ; Kentucky, tenth ; Alabama, eleventh ; Texas, twelfth ; New Jersey, thirteenth ; Maryland, fourteenth ; Arkansas, fifteenth ; Virginia, sixteenth ; and Ohio, seventeenth. New York and Pennsylvania were also far behind the South in the amount of wealth in proportion to population, the former State ranking twenty-second and the latter thirtieth. In 1860 the total assessed value of property in the United States was $12,000,000,000, and of this the South, with only one-third of the country's population and less than one-fourth of the white population, had $5,200,000,000, or 44 per cent.

In the light of these official figures, showing the enormous wealth of the South before the evil days which ushered in the great conflict, it would be more than folly for any one to repeat the old statements that Southern people of early times lacked energy and business ability. The man who still claims this must be forced then to admit that 6,000,000 non-progressive Southern whites were capable of creating as much wealth as 20,000,000 energetic people in the North and West. If he claims that this creation of wealth was by the slaves, he must admit the ability of their masters, who, with 4,000,000 slaves, could produce greater results than the 20,000,000 inhabitants of the rest of the country. It is not the aim of the writer to make any invidious comparisons, but the South and its people have long been misunderstood, and because of this they have been misrepresented. These facts are given simply to correct false impressions and to prove that the Southern people possessed a business ability and an energy that enabled them, in railroad-building, in manufacturing pursuits, and in agriculture, to compete with any other class of men in the world.

As the world's demand for cotton increased at such a rate as to cause the doubling of the South's production in ten years,—the crop of 1860 having been 5,196,000 bales against 2,445,000 bales in 1850,—it was inevitable that the capital and energy of that section should be largely centered in this business during that period, but the natural tendency of the people to devote much attention to railroad-construction and industrial pursuits has been clearly shown. Why then did not the South begin industrial development as soon as the war ended? First, because its poverty—greater than can be comprehended except by those who felt it—made it impossible. And if this were not reason enough, because of the

death or ruined health of hundreds of thousands of its foremost citizens in the war. The emigration to the West, the Southwest, and even to the North, numbered probably as many as were lost in battle. Finally, the utter demoralization of the labor system which followed the abolition of slavery, and the political misrule and debauchery of carpet-bag governments for ten years after the war ended, were enough to check progress in any country. It is difficult to portray adequately the poverty entailed upon the South by the war, or to give a fair conception of the magnitude of the financial loss. It has been estimated, conservatively, that the latter aggregated from $4,000,000,000 to $5,000,000,000. This is a greater sum than the entire capital now invested in all the manufacturing interests of the United States, and it is about eight to ten times as much as the combined capital of all our national banks. It is so great that it is impossible to comprehend it all, but a study of some details will give a fair idea of what it means.

It has been stated already that in 1860 the assessed value of property in the South was $5,200,000,000, out of a total of $12,000,000,000 in the entire country, or 44 per cent. In ten years there was a startling change. In 1870 the South had only $3,000,000,000 of assessed value, while the total for the whole country was $14,170,000,000. While the South grew poor, the North and West grew rich as never before. In 1860 the assessed value of property in Massachusetts was $777,150,000, compared with $5,200,000,000 in the South; in 1870 Massachusetts had $1,590,000,000 of property and the South $3,000,000,000. Such was the poverty of the South that the one State of Massachusetts listed for taxes more than one half as much property as the fourteen States of that section could show. The assessed value of property in New York and Pennsylvania alone in 1870 was greater than in the whole South. South Carolina, which in 1860 had been third in rank in wealth in proportion to the number of her inhabitants, had dropped to be the thirtieth; Georgia had dropped from the seventh to the thirty-ninth; Mississippi, from the fourth place to the thirty-fourth; Alabama, from the eleventh to the forty-fourth; Kentucky, from tenth to twenty-eighth, and the other Southern States had gone down in the same way, while the Northern and Western States had steadily increased in wealth. In 1860 the assessed value of property in South Carolina, according to the Census, was $498,000,000, while the combined values in Rhode Island and New Jersey aggregated $421,000,000, or $68,000,000 less than South Caro-

lina's; of course the true value is always greater than the assessed value. In 1870 the combined values in Rhode Island and New Jersey amounted to $868,000,000, and the value in South Carolina was $183,000,000. Thus, while South Carolina had $68,000,000 more assessed property in 1860 than these two States, in 1870 their wealth exceeded South Carolina's by $685,000,000. Notwithstanding the mighty industrial advance in the South during the last ten years, the building of 20,000 miles of railroad, and the increase in agricultural production, the assessed value of property is not yet as great as it was thirty years ago, and Maryland,—a border State,—and Florida, and Texas are the only States which have as much assessed wealth now as in 1860.

Without capital or financial friends; its State Governments largely controlled by thieves or ignorant negroes, the dupes and tools of unscrupulous white men; with hundreds of thousands of its young and most brilliant men dead on the battle-field or hopelessly wrecked in health; with thousands forced to seek a living in other sections; with disorganized labor and 4,000,000 uneducated negroes waiting for the General Government to give them "forty acres and a mule,"—who can wonder that the South made but little progress until 1880, and who can fail to be amazed at the marvelous growth of the last ten years?

[*TO BE CONTINUED.*]

PROGRESS IN THE ART OF WOOD-WORKING.

By C. R. Tompkins, M. E.

THE progress made in the art of wood-working forms an essential feature of the mechanical inventions and improvements which have distinguished the past century. This art was probably one of the earliest practised by man, and its importance is shown by the fact of its continuing to exist under conditions of constant development. As civilization has advanced, demanding in each stage more comfortable dwellings, the skill of the worker in wood has fully kept pace with the times. It is not necessary to go back of our own century to find evidence that progress in this art has been equal to that of any other branch of mechanical development.

There are parts of the Old World noted for the grand specimens of architecture in stone which have come down from the middle ages, but the slow and laborious processes of hand-labor by which those structures were erected rendered them so costly that none but the wealthiest could hope to secure more than the rudest and most primitive forms of dwellings. Our forefathers, in the settlement of America, on account of the scarcity of suitable materials and the great cost of skilled labor, were obliged to be content with log cabins, which seem to have been the prevailing type of dwelling until wood-working machinery came into use.

The saw-mill was introduced soon after the settlement of the colonies, previous to which all the cutting of lumber into boards or planks, both in this country and in England, was performed by hand by the process known as pit-sawing. The log was placed upon a pair of saw-horses high enough to allow one man to stand beneath the log while the other stood upon it, the two working a saw of sufficient length. Long after the introduction of the saw-mill, pit-sawing was practised in many ship-yards, and most of the planking and other timbers used in a vessel were sawed in this manner. Improved machines and appliances for wood-working, as well as in every other mechanical industry, have always met with strong opposition from the ignorance and want of foresight on the part of the workingmen employed. When the first attempt was made to introduce the saw-mill in England, the hand-sawyers by their

opposition practically placed a veto upon it. It is stated that in 1663 an enterprising company employed a Dutchman to erect a saw-mill in London, but that the enterprise had to be abandoned on account of the opposition of the hand-sawyers. In 1767 a saw-mill was erected and operated by a windmill at Limehouse, England, but it was soon destroyed by a mob. Another, erected in the south of Scotland about the same time, shared the same fate.

It is probable that the United States may justly claim the honor of being the first country to successfully introduce the saw-mill as an aid to the cutting of lumber. At least it was not until large quantities of sawed lumber had been exported by the Dutch from New York into England that the hand-sawyers would allow saw-mills to be erected in the latter country. There was less opposition to the saw-mills in this country on account of the abundance of timber and the demand of the colonists for cheap lumber for building purposes, while the hand-sawyers were few in number and confined to the few ship-yards. There was almost no attempt made to put hand-sawed lumber upon the market for building purposes. The saw-mill had the effect of rendering building materials cheaper and more plentiful, so that log cabins in the principal towns soon began to give way to the more sightly and convenient framed structures. These, although an improvement upon the log cabin, were necessarily very plain, from the fact that no machinery aside from the saw-mill had been invented for dressing it. Consequently all the lumber used had to be dressed and fitted by slow and expensive hand-labor, and, except in the case of a few of the more wealthy, no attempt was made for improvement in either style or architecture until within comparatively recent years.

Next to the saw-mill the most important machine that has been introduced, and one that has had more effect upon the progress of building than any other, is the planing-machine, which dates from the invention of William Woodworth, in 1826. Not only did the work of the planing-machine of itself give a great impetus to the art of wood-working, but its introduction demonstrated that lumber could be dressed rapidly by the action of rotary cutters, leading inventors to apply the same principle to machines for other uses. The planing-machine may be considered as an American invention, although rotary cutters were used in England long before the Woodworth planer was invented. There is no record, however, that any successful planing-machine, with an automatic feed, was ever put upon the market for wood-working previous to that time.

The same spirit of opposition which manifested itself among the British hand-sawyers against the saw-mill appeared among the journeymen carpenters upon the introduction of the planing-machine. As soon as it was demonstrated that boards could be successfully planed and matched by machinery faster and more accurately than by hand, such excitement and indignation were expressed among the journeymen carpenters that the building in which the machine was located had to be watched day and night for months, lest it should be burned. The carpenters claimed that, if machines of that kind were allowed to come into general use, they would soon be thrown out of employment and their families would suffer for the necessaries of life. In some cities they refused to lay flooring that was planed and matched by machinery. But the planing-machine gradually worked its way into public favor, and the carpenters found that, instead of injuring their trade, it made more work for them, with less hard labor than before. Building soon began to increase, and it has continued to increase just in proportion as the materials have decreased in price through the aid of machinery, until it is doubtful whether a journeyman carpenter could be hired to plane and match hard wood flooring by hand, as carpenters were obliged to do in former years. The effect upon the wages of the journeyman carpenter is another proof that machinery has benefited instead of injuring their trade. If we go back fifty years, when all the materials of wood necessary for a building were dressed by hand, the average wages of the journeyman carpenter was about a dollar per day of twelve to fifteen hours. Now good journeymen carpenters in the cities find no trouble in obtaining from $2.50 to $3 per day of ten hours, while in some places nine hours constitute a working day.

While the introduction of the planing-machine effected a great change in the cost of dressing lumber, yet in the earliest form it was far from the perfection found in the modern machine. One objection to it was the imperfect manner in which the lumber was planed upon the ends of the boards, there being no device, aside from the feed-rolls, for holding the ends down. Although they were placed as close to the cut of the knife as practicable, yet the distance from the center of the roll to the cut of the knife was always from four to six inches. Consequently when brought to the action of the cylinder knives, the end would lift from the bed and be shattered so that several inches had to be cut off of the end of each board as waste. The invention of the chip-breaker—so called—

was intended to remedy this fault, and it is applied now to all modern machines, not only to the cylinder but to the side cutters also, rendering the lumber both in the planing and matching as perfect upon the ends as in any other part. The chip-breaker consists of a small weighted roller or pressure-bar placed directly in front of the cylinder, so that the end of the board after it leaves the first pair of rolls is held firmly down to the bed until it passes the cylinder and is caught by the rolls directly behind. The beader is another improvement in wood-working appliances. The earlier wood-workers were satisfied with a machine that would simply plane and match, and where beaded ceiling was required the bead was struck by the carpenter with a hand-plane. But the progress in wood-working demanded a machine that would not only plane and match ceiling, but stick the bead also at the same operation, and the necessary devices for that purpose were soon invented, so that lumber now dressed at the mill is sent out in such a state of perfection that little or no hand labor is required aside from fitting it in its proper position in a building.

The molding-machine, with its modern improvements, has had much to do with progress in wood-working. Before the invention of this useful machine all moldings were worked by hand, and only the plainest and simplest style of moldings were used, but the demand for more artistic wood-work has brought the improved molding machine into general use. But still the demand for artistic wood-work continued, and it has led to the invention of many other complicated and useful machines. Not only intricate carved work, but irregular-shape moldings of the most elaborate kind, which were formerly worked only by hand, are now produced by special machines which perform their work more accurately and in less time and more cheaply than hand-labor. This change has demanded not only more accurate and skilfully-constructed wood-working machines, but a more skilful and intelligent class of wood-workers to operate them. In machine-stuck moldings especially there is a great change as compared with those stuck at the present time and those of a few years ago. Architects and builders are far more exacting than they were formerly. Once they were satisfied with moldings provided they were of the correct shape and of an even thickness, and, if the surface required smoothing down by the liberal use of sand-paper or sometimes the moderate use of a hand-plane, no objection was heard. Even with the imperfect state of the art the molding-machine was far preferable to the hand.

Competition among machine manufacturers, and the desire of one to excel another in quantity and quality of work, together with the increasing demand of architects and builders for better machine-work and less hand-labor, has brought the molding-machine to such a state of perfection that the most intricate designs in moldings are now made both in hard and soft wood, so smooth that even the use of sand-paper may be dispensed with. This of course requires mechanical skill on the part of the wood-worker in order to keep the machine in perfect adjustment and the cutting tools in perfect order.

Probably no other branch of the art of wood-working has made more rapid advances than the manufacture of furniture by the use of machinery. It does not require a very old man to remember when most of the furniture was manufactured by hand, and the village cabinet-maker, who was also an undertaker, was an important personage. When a young couple were married, the cabinet-maker was called upon to furnish the necessary furniture for house-keeping; when baby was born, none but the cabinet-maker could furnish him with a suitable crib; and when death invaded the domicile, his services were again called into requisition to furnish a suitable casket and assist in consigning the body to its last resting-place. But the rapid progress in the art of wood-working has wrought a complete change. The village cabinet-shop has changed to the furniture store, and undertaking has become a distinct branch of business, the supplies in both cases being obtained from the factories, where machinery performs the work more cheaply and accurately than hand-labor. It is within comparatively recent years that the makers of wood-working machinery have turned their attention to the construction of machinery specially adapted to the manufacture of furniture. Formerly it was thought that the same class of machines used in planing-mills and sash- and door-factories were also adapted to the manufacture of furniture. The use of such machinery tended to reduce materially the cost of production, but the pressure of competition in the furniture trade created a demand for better facilities in order to increase the output, while reducing the cost of production.

The band-sawing machine proved to be so much more rapid and better adapted to this class of work that it superseded the jig-saw, and the improved shaper—or, as it is sometimes called, the variety molding-machine—was another that became indispensable to the furniture manufacturer. This machine is comparatively an

old one, but it required many improvements to bring it to its present state of efficiency and adapt it to the varied requirements of the modern furniture-manufacturer. With the special attachments, it has almost entirely superseded hand-labor in working irregular and curved shapes. The dove-tailing machine is another illustration of the mechanical skill and inventive genius that the progress in the art of wood-working has brought into requisition. The perfection and rapidity of its work is such that with the labor of one intelligent operator the same quantity of work is performed in the same time that would be required by a half-dozen men by the old processes. Other special machines might be mentioned that have been introduced from time to time as the art has progressed, while manufacturers and inventors are constantly on the alert, so that no sooner does it become known that a new style of work is called for than a new machine is brought out specially adapted for this special purpose. Thus in the present state of the art of wood-working little is left to be performed by hand.

We often hear predictions from a certain class of men that the advance in the art of wood-working, as well as in other mechanical branches, and the introduction of labor-saving machinery, will eventually reduce the wages of the workman. It is safe as a rule to judge the future by the past, and we have already seen that the introduction of labor-saving machines, so far as the building business is concerned, has not only increased the demand for skilled workmen, but more than doubled their wages for fewer hours of labor. What is true with the wood-working trades is equally true with every other branch of mechanics where skilled labor is required. As late as the year 1856 first-class machinists could be hired at $1.75 per day, and the necessary machinery for a planing-mill or other wood-working establishment was little if any cheaper than at the present time, although there is nearly double the work upon a modern planing-machine that there was upon machines of that date. There is no question but with the present facilities a manufacturer would be able to put upon the market machines of the style of 1856 at much less than they were then sold for. Now machines of more than double the capacity of the former, with all modern improvements and conveniences, are afforded at about the same figures that were charged for them forty years ago. While manufacturers are realizing about the same profits as formerly, they are paying for the same class of skilled labor from $2.50 to $3 per day. This change has been brought

about by the countless labor-saving devices that have been introduced into the modern machine-shop, whereby one man with less manual labor is enabled to turn out double the amount of work in a given time ; still the market is not overstocked with first-class machinists. Therefore it does not appear that the introduction of labor-saving machines has had an injurious effect upon machinists' wages. The same rule will apply to every other branch of mechanical business. Experience has proved that the introduction of any mechanical device that will lessen the cost of production and enable the producer to put upon the market an article at less price or a superior article at the same will in every instance increase the demand. Nowhere is this principle better exemplified than in the products of wood-working machinery.

THE CITY HALL IN AMERICA.

By Barr Ferree.

THERE is no more interesting study than the development of municipal life, and this is especially true of the middle ages, in which the growing power of the municipalities was identical with the beginnings of the assertion of individual rights. It is not to be wondered that under such circumstances and in an architectural age the citizens sought to express their newly-acquired privileges in some architectural monument; hence nearly every European city of importance can boast a medieval city hall, which was the direct outcome of this feeling. So enthusiastic were the men of the middle ages in this work that the building of city halls almost died out in the fifteenth century, since every town had its municipal edifice and there was no further occasion for activity in this direction.

In this day, and especially in America, there is little of this old feeling left. We do not build city halls to express our municipal power or pride, or as thank-offerings to the genius of our cities; they express neither our wealth nor our culture. They are ordinary buildings, erected often with little thought of art; and even when the artistic side is attended to, the result is frequently so unsatisfactory as to make one wish it had been further neglected. Instead of being adornments to our cities, the city halls of to-day are too often the most objectionable structures within them; instead of being objects of pride, they are sources of regret. Philadelphia, it is true, possesses a vast municipal palace, which is not only the largest and most expensive in this country, but is one of the most pretentious buildings in the world. And when this has been said its chief merits have been catalogued. It is a huge, overgrown structure, much too large and costly for the uses to which it is put, and, notwithstanding the quantity of ornament loaded upon it, is a building which in no sense can be looked upon as admirable or as a suitable model for other communities to follow.

The American political system, with its bosses and "boys" and party rivalries, is not conducive to the progress of architectural art, and in this lies the explanation of much that is unsatisfac-

tory in American city halls. It is the length of the job, and what may be "in" it, that appeal to the mind of the average politician, rather than any art merit, of which he seldom knows anything. And so in the great cities the building of the municipal edifice has come to be dreaded, instead of being a source for public rejoicing, as was the case in the middle ages. For such is progress and practical art in the nineteenth century.

And this is the more to be regretted, since in the large cities the city hall is necessarily a large structure, providing accommodations for a multitude of offices, sheltering an army of officials, rendering an extensive and complicated structure imperative, and thus calling for the exercise of the highest architectural talent as well as the expenditure of a vast sum of money. In large cities the city hall, to be worthy of its name, should give accommodation to all the departments of the city government, or at least all such as cannot, for reasons of their own or for the exigencies of public business, be included under the same roof with miscellaneous offices. Thus when a city finds more of its departments out of the city hall than in it, as is now the case with New York, and is thus put to a great expense for rents as well as the inconvenience caused by the separation of closely-related departments, the city hall ceases to be such except in name. From this it follows that the larger the city the more important the city hall becomes, and thus, though quite foreign to its conception, it expresses, in a measure, the extent of the community.

It too often happens, however, that the increased size and importance of the structure lead to fresh difficulties. The idea of size is exaggerated out of all due proportion, and a big building or a high tower or some other monstrosity is regarded as an essential part of the design. This is the chief fault of the Philadelphia city hall, and, to a certain extent, of the new municipal building now in process of erection in Minneapolis, in which the coarseness of design and exaggerated largeness of parts spoil a large and costly structure. In both these structures—and the list might be extended by many others, did space permit—the most evident error lies in an assumption of monumentality, which is one of the most difficult of architectural qualities to express, and which is by no means gained, as many architects seem to suppose, by simply large building. To a certain degree the city hall is a monumental structure. It expresses the dignity of the municipality—or should do so—whether it expresses its intelligence and wealth or not. But

NEW YORK CITY HALL.—JOHN M'COMB, ARCHITECT.

American architecture is not an architecture of monuments, and our efforts towards imposing structures are seldom successful.

Apart from any architectural considerations this is quite as it should be. Our cities are not governed by their most intelligent citizens, nor is the municipal culture of a quality of which any one may be proud. Be our architects ever so advanced and our city fathers ever so docile and willing to obtain the best, the lack of representation of the best classes of citizens in the governing body must invariably result disastrously to architecture. Why? Because no one in the determining body knows which design is better than another, or why this one should be selected in preference to that. And this holds true in cities large and small, in villages and in towns, and the latter rather than the former, because in larger communities the force of public opinion, though not always well or ably expressed, may sometimes, by great good fortune, overcome the ignorance which thrives in most exalted quarters and through sheer popular discontent impel the selection of a tolerable design.

Yet while all this is perfectly true, a decided advance in the designing of municipal structures may be seen in the present time as compared with a period only a few years back. Buildings like the

TOWN HALL, NORTH EASTON, MASS.—RICHARDSON.

DETROIT CITY HALL.

CITY HALL, SYRACUSE, N. Y.—C. E. COLTON.

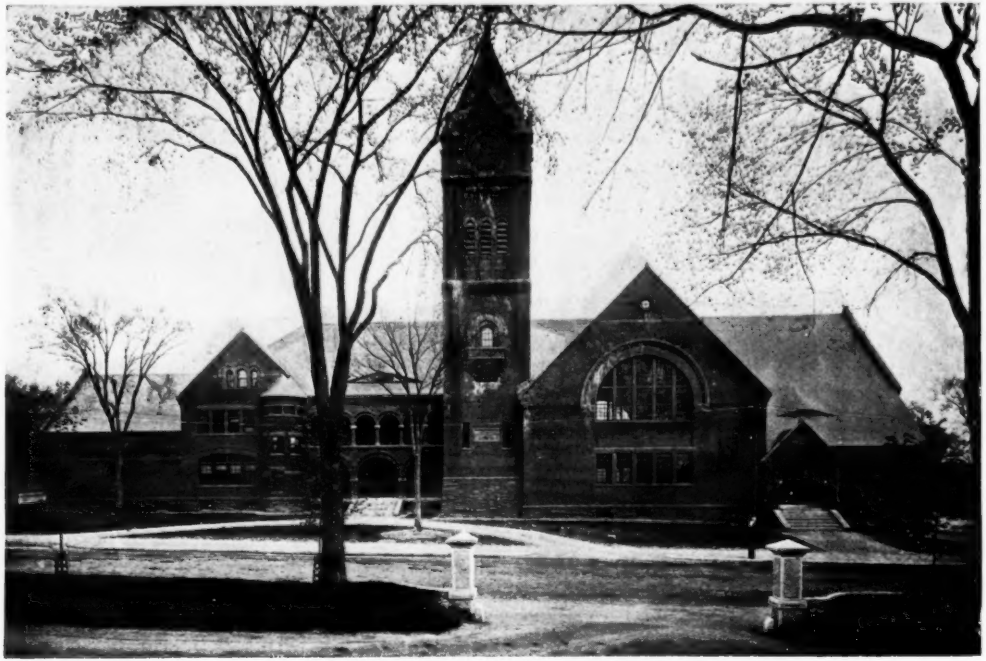
city hall of Milwaukee or the old city hall of St. Louis,—perfectly featureless edifices whose domes only help to make the poverty of the design more apparent,—and even semi-respectable buildings like the city hall of Chicago, or pretentious things like that of Philadelphia, have long ceased to be possible. Architectural taste has grown out of the rut represented by the first examples, while the errors of the last one are too conspicuous to permit any defense. The most successful of recent efforts are to be found in small halls rather than in large ones. Of these the city halls of Albany, New York, and of Cambridge, Winchester, and North Easton, in

NEW CITY HALL, ST. LOUIS, MO.—ECKEL AND MANN, ARCHITECTS.

Massachusetts, may well be taken as examples. The last named, especially, ranks among the most beautiful of Richardson's designs, and shows how thoroughly admirable the municipal buildings of a small community may be made, and what an addition they may become to the architecture of the town. Very different as each of these four designs are, they have this common characteristic,—a careful subordination of any evident effort. There is no straining for effect, no attempt to impress by some gigantic feature. They are calm, careful, scholarly buildings, each of which might well be taken as a model for town halls in other communities of similar size and importance.

We have no city hall in any of the larger cities nearly as successful as these. It may not be that our architects are incapable of handling the more complicated problems suggested in larger buildings, for they are solving other questions quite as complex and difficult every day. Doubtless the simplicity of the plan of the small town hall has much to do with the success of the designs. There is no need to house innumerable bureaus with multitudinous subdivisions and clerks. In the smaller towns an office for the mayor or chief executive, and his clerks, with a room for the aldermen or council, and one or two committee rooms, suffice for all necessary purposes. Even when court-rooms are included, the complexity of the edifice is not greatly increased. To these, in many instances, is added a room for public meetings, the town hall pure and simple, which may readily be made the most conspicuous feature of the design, and thus help in the making of a successful building rather than hinder it.

This latter feature is, of course, quite unknown in the halls of large cities, but the difficulties of the problem are not lessened by its absence. One of the most difficult features presented in large cities is the building of a hall which will continue to be large enough for municipal needs for a term of years. Philadelphia has undertaken to solve the problem by building a structure much too large for current necessities. Brooklyn has sought relief by erecting a series of additional buildings, a group not without some picturesque variety, but unfortunately wanting in individual merit. Boston must at once build an entirely new hall, or enlarge its present building to such an extent as to make it practically a new edifice. New York has seen its municipal departments overflowing into a dozen outside structures at the cost of an enormous rent-roll, and is still undetermined in what manner to find relief. In that

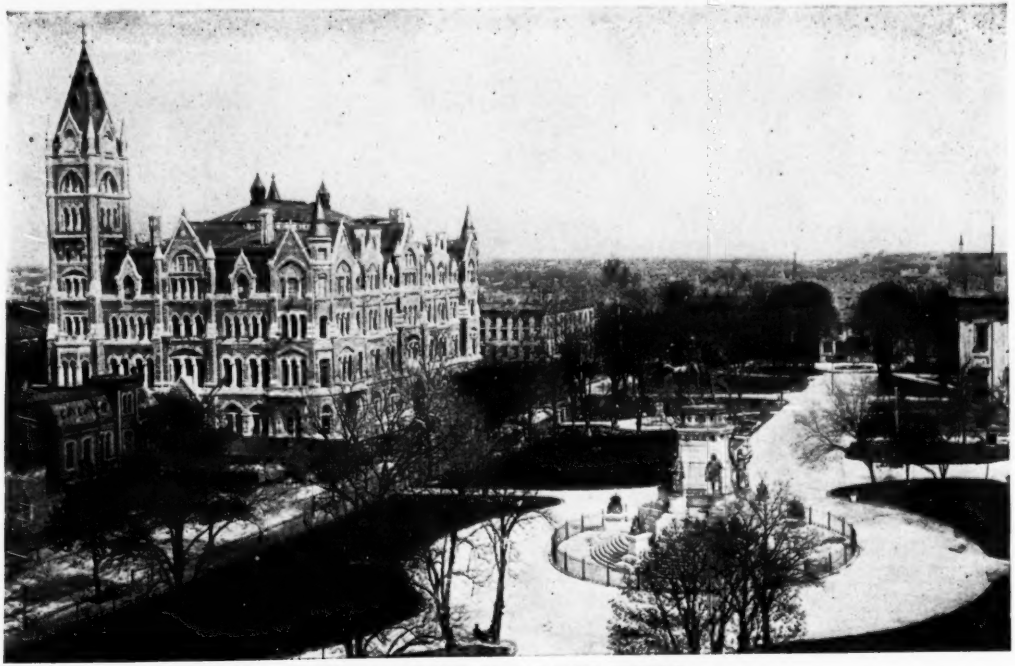


TOWN HALL, WINCHESTER, MASS.—RAND & TAYLOR.

city, however, the question turns more upon location than upon ways and means, though it is difficult to understand why, with the ample available ground in City Hall Park,—which is now chiefly appreciated by an endless army of loafers,—there should be any hesitancy on this score.

The simple resolution to build will not solve the problem in the metropolis or elsewhere. Notwithstanding the lack of success which has attended many attempts in municipal architecture, the public has not outgrown the idea that the city hall must be an impressive structure. And public opinion is quite right. But what a thing should be is often very different from what it is. Our cities are so rapidly becoming examples of commercial architecture that it seems not unreasonable to ask that in one type of building at least some monumental feeling be permitted, into which the ornamental shall be allowed to enter to a greater extent than into a business building. But the large buildings have failed so often to fulfill this public feeling that it would seem to be better, in the end, to treat our city buildings as business buildings, which, in very truth, they are. This does not mean that a city hall should be a gigantic office building, like the Masonic Temple of Chicago, or the Produce Exchange of New York, or the Ames Building of Boston, admirable examples of commercial structures as they are; but the problem should be attacked in a business manner, treated in a common-sense style, and the result, in a measure, left to take care of itself. It is well enough to have a dome, if the style of architecture permits it, or a tower, if that be more in keeping with the design, but neither of these elements should be made the fundamental part of the whole, nor should the effort be simply to have a great dome or a lofty tower, regardless of everything else. Instead of being the first consideration, such things should be the last. The greatest dome will not render any building more useful, nor will its utility be added to by the loftiest or most beautiful tower. Like every modern structure, the city hall has a use, as well determined and as evident as that of an office building or a hotel. No one would think of putting a dome on an office building for simple external grandeur, and in this utilitarian age towers are filled with rooms and made as useful as the lower portions of the structures they adorn.*

* The Pulitzer Building, in New York, is the most conspicuous illustration of the application of the dome to a commercial edifice, yet it is filled with rooms and made thoroughly useful. Unfortunately the architectural effect is not such as to tempt others to repeat the experi-



CITY HALL, RICHMOND, VA.—E. E. MYERS, ARCHITECT.

CITY HALL, KANSAS CITY, MO.—S. S. CHAMBERLAIN, ARCHITECT.

ENTRANCE, CITY HALL, KANSAS CITY, MO.

BALTIMORE CITY HALL.

Ornamental features such as these seem to enter more naturally into the design of municipal buildings than into any other sort of building, unless it be a church. Yet in looking at the dome it is well to remember, no matter what its architectural success may be, that the merit of the building is to be judged solely by the way in

ment. The tower of the Auditorium Building, in Chicago, is filled with offices, and the towers of the Madison Square Garden and the Judson Memorial Baptist Church, in New York,—to cite two widely different structures,—are put to similar utilitarian uses.

which the structure itself answers the necessities which have called it into existence. The town hall differs from the city hall in having to house a limited number of departments. Cities like New York, Chicago, Philadelphia, Boston, Cincinnati, St. Louis, and Minneapolis, require suites of offices, exactly identical in design and inten-

NORTHERN ENTRANCE, NEW PUBLIC BUILDINGS, PHILADELPHIA.—
JOHN MCARTHUR, JR., ARCHITECT.

CITY HALL, BUFFALO, N. Y.

tion with the rooms to be found in every modern office building. We do not need—unfortunately, for there is a wonderful fascination in such things—monumental apartments and stately rooms to show to chance visitors. Needlessly expensive as many of our city governments are, workrooms, not playrooms, are necessary for carrying them on. The Council of Venice could well afford to sit in one of the stateliest rooms in the world, richly adorned with masterpieces of painting and other objects of art : the city fathers of an American municipality would be as much out of place in such a room as they themselves would be in medieval Venice. Even the reception-room

PROPOSED NEW CITY HALL, BOSTON.—E. M. WHEELWRIGHT, ARCHITECT.

CITY HALL, ALBANY, N. Y.—RICHARDSON.

and ball-room of the Paris Hotel de Ville would be out of place in an American building of this class, because they would be utterly useless, and thus, no matter how great their architectural value, quite foreign to the spirit of the American city hall.

Eliminating these elements, the stern utility of the problem becomes apparent. The city hall is built because it is to be of use, and the more useful it is, and the more convenient for the trans-

action of public business it is made, the more admirable it is, and the more it is to be valued as a model for future structures. This does not mean that an ugly city hall is to be sought, though unquestionably an ugly useful building is to be preferred to a useless handsome one: beauty and utility are not opposed elements, for each helps the other to make the structure a success. If the utilitarian necessities of the municipal building can be satisfactory expressed in the Renaissance style, as is attempted in the city halls of Boston, Providence, and Baltimore, or in Romanesque designs, like the new city hall of Cincinnati, or in hybrid styles, like the city halls of Philadelphia and Minneapolis, well and good. It is not the style of the building, but its utility, which makes it good and great and acceptable to the community.

After the useful the ornamental. And this is to be sought more in the architecture as a whole than in special attention given to some one feature. A tower which is a natural part of a design, as is the case with the city halls of Albany and of Cambridge, and of several other small New England cities, provides a very useful, and in these instances a very successful, way of emphasizing the monumental nature of the edifice. On the other hand, where a tower is built simply as a tower, as something extending upwards into space, without sense or reason in its smallest stone, as is the case with the Philadelphia city hall, no words of condemnation can well be too strong. There must be reason in the ornamental parts as well as in the useful, and it is in the beauty of the detail and general workmanship that a city hall, as well as any other building, will be successful and merit the praise or condemnation it receives.

Probably no class of structures is condemned so frequently, and with so much justice, as the city halls of America. We attempt too much: we are not satisfied with a calm, rational treatment of the problem, but seek to impress by means beyond our powers, which too often produce only contempt or ridicule. In the nature of the problem itself there is no reason at all why our city buildings should not be as successful as our blocks of business houses, our suburban residences, or many of our churches, unless it be that few architects are called upon to design a city building more than once. There is a great deal in being familiar with the kind of structure one is working at, and one reason why we have succeeded, on the whole, in these special forms is the frequency with which our architects handle them. Another element against the betterment of municipal buildings is the taint of jobbery and cor-

ruption which hangs over them, and the consequent reluctance of the best architects to compete for them. Competition is not without its merits in obtaining good designs,—if mere drawings are sought,—but open competitions, free to all, in which the whole world may take part, offer no attraction to well-established and successful architects, who alone are entirely competent to undertake such work. These conditions add very materially to the difficulty of obtaining good structures, and, if a city hall is to be a success, it is, in the nature of things, more a miracle than the result of a well-ordered succession of conditions. More than anything else, perhaps, in the way of progress and good results is the lack of comprehension of the real problem which too frequently pervades the most cultured communities.

OUR COSTLY GEOLOGICAL SURVEY.

I. A GLIMPSE OF ITS RECORD.

*By Senator Edward O. Wolcott.**

ALMOST every branch of the public service comes before some committee of Congress. The Geological Survey comes before none. If the Secretary of the Navy desires to make an experiment costing a thousand dollars, he comes to this body, presents his case to the Naval Committee, a bill is presented to Congress, the subject is investigated, and if it is found wise, the bill is passed. We never hear of the Geological Survey except as the Committee on Appropriations reports the amount to be expended for it. All the Senators in reach of my voice may not be aware of the fact that the Geological Survey was founded, was born, in an appropriation bill. The statutes making the Geological Survey valid and legal occupy less than a page of the Revised Statutes of the United States, and consist of a few excerpts taken year by year from the appropriation acts passed by Congress.

When I offered an amendment cutting down the appropriation for the paleontological survey, I was met with the very just criticism by the Senator from Connecticut who sits in front of me [Mr. Platt] that the cutting out of that particular paragraph might be considered as a reflection upon Professor Marsh (of Yale), who has had charge of it. I also have great admiration for that eminent scientist. I have no doubt that his researches have been of much value. I know that he is a gentleman of character and ability and attainments.

But I struck at that appropriation because at that time we had nothing else to strike at. It was an amendment by the committee inserting some $36,000 in favor of the paleontological survey which had been left out of the bill as it passed the other house. It is true it was with some misgivings of conscience and without information as to why it should be wholly stricken out that I made the motion. But the doubt I had in that case is quadrupled by the

* From a speech delivered in the United States Senate on July 15, 1892, as the result of which the appropriation was reduced $240,000.

doubts I have, and I think many Senators have, when they are called upon to vote for the Geological Survey the sum of $562,000, which, when it leaves this body, nobody on earth directs but the Director of the Geological Survey,—accountable to no man and no men, accountable only to the scientific bodies of the United States, who may criticise the wisdom or unwisdom of the work. We year after year appropriate these vast sums of money without any suggest on of daylight at the end of them.

The authority was originally conferred solely for the Territories. Attempts were made from 1879 to 1882 to secure authority and put this topographical and geographical work in the States. That authority could never be obtained from Congress until in 1882,—at the end of an appropriation bill, in the phraseology appropriating one hundred and fifty odd thousand dollars to complete a geological map of the United States. That authority to complete a geological map of the United States constitutes the sole shred of authority which the Director of the Geological Survey has to go throughout the States of the Union and carry on these expensive and extensive investigations.

We have already expended $6,822,405 upon these surveys. This subject was carefully investigated in 1885 and 1886 by a joint committee of both houses of Congress, and the chairman of the Committee on Appropriations was the chairman of the joint committee. Their investigations were carefully extended, and their report is most lucid. Unfortunately they were precluded from passing upon the wisdom or the unwisdom of the Geological Survey, and their report states at its inception that that question was excluded from them. All they had to pass upon was the question as to whether it should be associated and merged in the Coast and Geodetic Survey.

The question as to the wisdom or unwisdom of the Geological Survey has never yet been investigated or reported upon, but it is significant to notice what Major Powell stated to the joint committee in 1886. He is spoken of here and everywhere as a gentleman of the highest character, and I have no doubt he is. He has certainly proved himself to be what is known in the West as a very handy man, for in some unaccountable fashion he seems to exert a subtle and refined and underground influence on everybody, so that when we talk individually with each other we say: "There is something wrong about this survey"; and everybody says: "Yes, that is so; but you must not touch the paleontology, or you must not touch

the geology, or you must not touch the geography," or you must not touch this or that.

I do not question Major Powell's ability, nor do I discuss his extreme fitness for securing from Congress an immense appropriation; but I do say that the work up to this time does not bear sufficient fruit, nor has it borne out his promise made in 1886. He then assured the joint committee that he would complete the geological map of the United States in twenty years, and that it would cost $18,000,000. He has filed no report since 1890. The report filed then shows that at the rate he was progressing from 1886 to 1890 it will take more than a hundred years to complete his map, and that it will cost the people over $100,000,000.

Year after year we are called upon (the only way the subject is brought to our attention being by one short clause in an appropriation bill) to give these vast sums of money towards the completion of a map which will never be finished in our day or in the next five or ten generations of people, at an expense which not only bears no fruit to us, but which in my opinion is an absolute discouragement to scientific inquiry the whole United States over. I think it needs no argument to show that wherever the Government has assumed to foster and protect and encourage literature, or science, or art, by its donations and by its vast appropriations, all incentive to competition, all incentive to investigation is gone, and the specialists become tools of a Government of appropriations;—they sink their own individuality, and all chance for individual investigation or progress is gone.

I say that it is without great intelligence that any one can move to cut down this Survey a specific sum. If the appropriations were all cut off, the country would lose but little, for it is a fact that as to the whole vast expanse of this country the geological work yet done amounts to less than the area of the desk in front of me in comparison with the area of the whole Senate Chamber. Who is to limit the extent or the character of the geological work to be submitted? One of these eminent scientists can take a twig of a tree or a piece of rock that means to us nothing and he can fill a book as big as these before me as the result of his discoveries, and from a rose leaf he will fill a volume.

A geological map of the United States, under the fostering care of the Committee on Appropriations, will cost this country a sum in the end greater than the present amount of the national debt. Year after year we are asked to yield for the present, to give way,

because, although there is something wrong about it, yet some day we will investigate it; for the present let it go on, for these are a refined lot of people and they are doing much valuable work.

Professor Agassiz, son of the great Agassiz, reported to the committee in 1886 that the work was valueless and expensive and appropriations were useless. This letter was brushed aside (although he was one of the most eminent men connected with Harvard University) in favor of the testimony of people who are in the Survey. Major Powell has managed to include within it every man who can make trouble, and every man who has a friend on this floor or the other. To every man outside of it the Survey is useless, and to every man inside of it the Survey is of great value and should be encouraged.

I do not know when it is the time for us to speak. Next year the appropriation will be the same or larger, and we will be met with the same request, the same suggestion, in the same good-humored way that no man likes to resist: "Let it go this time; we will do something next time. There is something wrong about this, but just let it go now. We want to adjourn pretty soon, and we do not want to make trouble over this bill, and this is not the particular time to cut it down."

It is to me nothing. I love to hear of the discoveries and the growth of science. I share in all the pride of every American citizen at all the growth and progress of our people in civilization and in culture; but I do not think we are honest men if we stand here year after year and give from $100,000 to $1,000,000 of the people's money for a survey which accomplishes no useful purpose, and for which we can give to our people on our consciences no adequate explanation. It does not help us in any respect. It cannot help us in time of war, for the publications are sold, every one of them. It is of no use to an invading or a defending army. The gross proceeds from the sales of this magnificent survey, which we endow so munificently, are about $1600 a year. That is the market value. That is what the public pay for them.

What should be eventually done with the question no man can clearly see. It is very possible that it is time to relegate it to the States; that we should say in some broad way to the different States of the Union: if you care to investigate your swamp districts and see how you want to improve them; if you want to find out whether there are minerals in your mountains; if you want to find out whether the soil of your valleys is fertile, and you prefer it,—we will

give you our volumes and the use of our valuable laboratory, and we will help you with some appropriation. It may be that is the best way out of it, but there must be some way. Year by year we have been going along helplessly, and we never find it.

They are delightful men in charge of it, competent men, good men. Thrown on their own resources, they would make a very much better living, and would have in themselves more self-respect than living at the public crib. There is no personal reflection respecting any one of these people. But, for instance, one of them in a Western State was instructed to report upon a mining district fourteen years ago. There have been thousands and thousands of dollars expended on that survey. Meanwhile the district was discovered, was prospected, was worked, was developed, thousands of dollars taken out of it, and the camp abandoned. But the report is not yet furnished. Take the illustrations of Leadville alone. It is a most valuable monograph. Every surveyor who comes out there fresh from college writes me to get a copy of it. It is one of the most magnificent that was ever given away by the Government. The illustrations cost $28,000. Every one of these valuable monographs, every one of these valuable reports, comes after the fact. There is not a blessed one of them that guides the prospector. After you have discovered your ore and taken it out, these very intelligent and cultivated men come along and say, "That is beautiful." I find here marvelous geological descriptions showing just what happened. It is always after the fact. It is beautiful knowledge, but it is not the knowledge that this Government should be called upon to pay every year from half a million to a million dollars for.

II.—REASONS FOR SUPPORTING THE SURVEY.

By N. S. Shaler.

VIEWS as to the functions of government are almost as ancient as such institutions and are very diversified. Of old the theories tended to affirm the duty of the man to the State; at present the main question is the duty which the commonwealth owes to the man. In all civilized countries we are well by the day when half the ablest people of a great State could exhibit the mad-cap devotion that our forefathers gave to the miserable race of

Stuarts. In our time, to thoughtful men, the State is a useful machine, valued for the good it gives or may hereafter afford. We are willing to yield it both property and life,—as willing as men ever were to yield it their treasures,—but we make the sacrifices with a keen sense of the ledger account and not from blind patriotism.

It has long been recognized that the first duty of a government is to give to each citizen a full and even chance to profit by his natural endowments; hence the first philosophical proposition in statecraft to be well affirmed was that the government should protect men from the trespass of their neighbors. To effect this end it is assumed that the government has a right to demand all that the citizens can give in the way of service. On this foundation many other like conclusions have been rested: The State, as a whole or through its civic elements, must protect against disease; it must guard against ignorance which threatens the efficiency of its citizens; it must see that the people of the commonwealth are provided with every ennobling advantage which clearly cannot be secured by the volition of individuals or by the assistance of corporations.

Some publicists have held that all the motives of our American State which are embodied in the Federal or local governments have been altogether derived from the old world. It is true that our statesmen of a hundred years ago were too wise to be innovators. They limited their action as far as possible by the experience which had been gained in other lands and other times, and so built our national edifice altogether of well-tried materials. But in the century which has elapsed since their work was done there has grown up in our government a new element of its institutions, which is a net addition to the theory of the ancient States and which is destined to have a large place in our public life. This novelty is found in the development of our scientific establishments which are supported on the public revenues. Although like institutions have grown in other lands, those of this country are purely indigenous, and have a dignity and efficiency which give character to our government work and which excite the admiration of all learned men in the old world.

It is easy to see that the foundation and development of the official scientific bureaus in this country are due to the peculiar conditions of the land and people, and to the habits which rest upon these natural foundations. Inheriting a rich and unknown

land, a territory which, unlike the old world, had not been for thousands of years searched for its resources in soil and mine, our forefathers were naturally led, by their purely intellectual as well as their economic interests, to tasks of exploration. They became an exceedingly inquisitive people, curious to know all that could be learned concerning their great heritage. Even the busy philosopher and statesman, Jefferson, eagerly gathered the remains of extinct animals which lay, half-buried, about the salt licks of the Ohio valley and sought to interpret them. He blundered in his work, but no part of his vast intellectual endeavors tells so much as to the spirit of his time as his studies of our fossil animal remains.

The best work which men do is usually done half-blindly, yet not without foresight, for the deeds fit the needs, and they become slowly organized into a system by process of perfectly natural development. In this manner from small beginnings the scientific establishments of our Government in the astronomical observatory, Coast and Geodetic Survey, the Fish Commission, the Bureau of Ethnology, the weather service, and the Geological Survey, have grown out of recognized needs, have been approved by our people in their inception, and have been led from their beginnings to their present great accomplishments by discerning and watchful care. It seems fit that our legislators for the time being should recognize the fact that these agents of public inquiry are among the most natural products of our national life; that they are the most characteristic part of our established polity; and that it is the duty of those who legislate for them, not only to care for their proper management, but discreetly to extend and strengthen the good work which they do.

The recent action of Congress in amending the Sundry Civil Bill so as to reduce the appropriations for the Geological Survey to about one-half of the amount voted at the previous sessions affords a good opportunity to discuss, in some detail, the functions of this Bureau, which is a fair type of our many similar institutions, and at the same time to consider the ways in which the national legislature should undertake to revise and control the administration of such work. In this inquiry we should in the first place note the conditions which led to the establishment of this Survey and to its recent rapid development as a national bureau.

In the early part of this century a notable change occurred in the economic history of this country. We had long remained in

ignorance of our under-earth resources ; our economic development had been limited to the cultivation of the soil, the manufacturing arts, and commerce. When the public awoke to the fact that a great part of their heritage lay in the under-earth, mining began to take a place in our industries. The first ventures were mostly unsuccessful, and it became evident that we must avail ourselves of the knowledge possessed by geologists. In rapid succession nearly all of the older States established geological surveys and published their reports for the information of the people. Although much of the work was done with scant means and in a cursory manner, the people found the results so far profitable that again and again they have voted large sums to have repeated in a more thorough manner, and in the light of the advancement of science and art, the tasks of exploration which appeared to be sufficiently well performed at the times when they were performed. Experience seems to show that in less than the lifetime of a generation the swift advance in our knowledge as to the resources of the under-earth and the marvelous increase in the demands we make upon them require new inquiries in the best-known fields, and the labor we thus are called on to bestow is richly repaid.

When the Federal Government began to explore its great empire in the West, and to make ready its territory for division among the people, it naturally undertook to gather some knowledge as to the mineral resources of the land. Thus it came about that nearly all the numerous expeditions which were sent into the western wilderness were accompanied by geologists, who, though moving hastily and seeing nothing but what lay near their line of march, brought back a rich harvest of information, which showed how much was to be won by systematic inquiry. Next after these preliminary raids for information, and as fast as the savage tribes were reduced to something like order, the Federal authorities proceeded to organize surveying parties, which undertook to prepare maps and reports concerning certain limited fields that gave promise of rich mineral harvests. Several of these territorial surveys, exploring particular fields in the Cordilleran district, especially those directed by Hayden, King, Powell, and Wheeler, did work which remains of great value and is properly to be reckoned among the notable achievements of our people. Owing, however, to the lack of central control, the results obtained by these several corps were not of coördinate value, and waste arose from the divided administration, so that Congress wisely determined to unite the Surveys.

The advantages which came from having the work of exploring the Government domain in charge of a single bureau were so distinct and unmistakable that the need of extending the same system to the whole country became evident to all those who were conversant with the aims and results of geological inquiry. The work done by the several State surveys, though in the main trustworthy, was naturally variable in character and gave no basis for good generalized statements concerning our natural resources. There was obviously a tendency to exaggerate the importance of the economic resources of each of these separate fields. The men who pursued the several inquiries knew little of the conditions beyond their own bailwicks, and so produced reports which were made from as many different points of view as there were commonwealths supporting these special bureaus. Thus it came about that in the important resources of coal and iron it was impossible for the consumer to ascertain the relative value of the deposits in different parts of the country. In some States the reports appeared to show that the iron ores were almost destitute of phosphorus and the coals of sulphur, while the accounts of other neighboring commonwealths would indicate high percentages of these substances. A good many economic ventures came to failure from the lack of accuracy in such determinations. Moreover, working from these separate centers and without the accord which can only be insured by unity of administration, it proved impossible to obtain the well-ordered data required in order to estimate the age of our geological formations. This question, though it may appear to be of a recondite and purely scientific nature, lies at the foundation of all the important economic work which is effected by geology. The most of our valuable mineral resources are, each after its kind, distributed in strata of particular ages. The geologist cannot tell the public where to look for these materials until he knows just how the rocks of a particular age are distributed over the surface or hidden beneath a covering of more recent formation.

There was another need, yet more insistent than those above described, which led our Federal legislature wisely to undertake to enlarge the scope of operations of the Government survey, so that it might include the whole of the national field. At every step towards the organization of civilization, in this new land, great inconvenience has been experienced from the lack of trustworthy maps. This evil was, if anything, more serious in the older States than in the region of the West, where the Land-Office maps, made in

connection with the partition of the public domain, gave some idea as to the courses of streams and the positions of lakes, though they afforded no conception as to the attitude and form of the surface. The inconvenience arising from the lack of charts had been borne with characteristic patience by our pioneer folk, who had never learned by experience the great help which maps can lend. In the period of the Civil War, however, the people, both North and South, had a practical lesson as to the value of these instruments. That struggle was made vastly more difficult—its duration was much prolonged and the expense of blood and treasure greatly increased—by our ignorance of the field of action. Those who know the use of good maps in the work of war probably will all acknowledge that the loss of time alone in attaining a settlement, due to the lack of topographic information, was at least a year. Discreet commanders do not dare ventures, which they would otherwise willingly essay, when, in so doing, they have to grapple not only with an enemy but with an unknown earth.

It is scarce a decade since this exceedingly great task of mapping the surface and describing the strata of our vast domain was fairly undertaken. In no other similar work had the preliminary obstacles of organization been so rapidly overcome, or such progress made in the execution of the task. The first duty of the direction was to obtain, as speedily as possible, as a foundation for further inquiries, good topographical maps with contour lines designed to show with approximate accuracy the shape of the surface and the altitude of its parts above the level of the sea. In no other country has this difficult undertaking ever gone forward with anything like the speed with which it has been advanced by this survey. Partly by coöperation with the several States which have contributed money for the end, but in larger measure without such assistance, more than half a million square miles of our territory have been mapped with an accuracy not before attained in this country, except in the work of the Coast and Geodetic Survey, which has delineated the narrow strip along the shore which concerns the mariner. Coincident with this fundamental labor of charting the land, which has been carried on with such speed as to give us hope that in twenty years we might obtain a map of our whole country, the Survey has pushed forward a set of inquiries which have a more or less immediate, but always distinct, reference to the development of the economic work it has in hand. It has advanced the interpretation of the older rocks in the Appalachian

district to a point where the confusion which has retarded the work of geologists in this field has in good part been cleared away. It has interpreted the rocks of the iron district of the Michigan peninsula, so as to remove the most of the difficulties which beset that entangled field. It has unraveled the exceedingly complicated structure of the Leadville district, giving to its miners a basis on which to continue their explorations, which they deem of exceeding value, and it has done like service for other miners of gold and silver and for miners of quicksilver and of coal. The results of the work, so far as done and put through the printing-press, include 615 map sheets, ten volumes of annual reports, and 100 volumes of memoirs and bulletins,—a mass of information already greater than that which has been gathered concerning the resources and conditions of any other country. With its natural growth it will, in the end, constitute a library of learning concerning our land, great in bulk, but no wise disproportionate to the importance of the information it will afford, all of which can be made readily accessible by means of a general index.

When we consider the difficulties which attend the beginnings of such a national work, these results may fairly be regarded as one of the largest intellectual and executive achievements which has been accomplished in this country. It is doubtful if any land can show anything like it. It seems to the present writer that this success has been due, in the main, to the singular administrative capacity of the present director of the Survey. His experience as a soldier in siege and battle, in a measure equalled by few of the survivors from our Civil War, extended by a generation of work in the difficult conditions of our frontier, has served to train him in foresight in that valuable art of meeting obstacles before they actually arise. It might have been expected that difficulties would be encountered in blending the work of the national bureau with that of the existing State surveys, but in fact these relations have been and remain practically without exception concordant. A serious obstacle was encountered in the fact that at the outset of this work on a national scale there were few experts in the earth-science who could be called upon to give their whole time to the labor. The men who had the needed knowledge and training were, to a considerable extent, engaged as teachers in the various schools of the country, and held positions from which they could not be tempted by the pay or station which a place in the Federal bureau would afford. The obstacle has been surmounted by em-

ploying these trained experts during the periods of leisure at their command on the tasks which their long experience fitted them to perform. This arrangement, necessarily of a temporary nature, pending the development of a corps complete in itself, is one which will seem reasonable to every fair-minded critic of the undertaking.

It goes without saying that blunders have been made in the prosecution of this great work. Such are inevitable in all private business; they are in the quality of deeds. Whoever can base his judgment on personal experience will be content if the administrator of such a task makes good use of the lessons which his errors teach. The present writer has had experience in State survey work, and has followed in an intimate way the administration of the national geological bureau. He does not hesitate to say that the percentage of mischance has been singularly small.

In conclusion it may be said that the United States Geological Survey has in hand the task of guiding in the great task of developing our earth resources. Its history fairly raises a presumption, which is in effect overwhelming, that its work should be maintained and extended. It surely indicates that in justice to national interests no revolutionary changes should be made in the administration of this Bureau without careful deliberation and a clear understanding of the interests of the people which have been committed to its care.

WHAT ENGINEERING OWES TO CHEMISTRY.

By A. L. Griswold, M. E.

LONG before chemistry assumed the dignity of a science the debt of engineering to chemistry had begun to accumulate. At the same time engineering began to repay the debt. Since no definite account current between these two eminent factors in the world's progress has ever been kept, it is impossible to say how the balance stands, or on which side; the account must forever remain unsettled. In a general way, all intelligent persons know that while engineering takes materials, natural and artificial, and transforms them into products of service to man, chemical industries furnish many of the resources now at the command of engineering skill. But all have not considered the extent of the ever-increasing interdependence of these sciences.

When a series of extremely able and interesting articles, written by the skilful chemist of the Pennsylvania Railroad, began to appear in a leading railroad journal several years ago, many persons expressed surprise that a railroad company should find it profitable to employ a chemist. When it further appeared that the duties of his position made necessary the employment of an able assistant, the question as to what such men could find to do that would repay their salaries, with profit to the great corporation employing them, must have occurred to many minds. But no one rose from the perusal of those articles with any doubt that the employment of chemical experts was a wise innovation on the part of the management of a great railroad system. How the purchases of supplies for this road, amounting to millions of dollars annually, are intelligently guided; how oils, paints, and other articles far too numerous to be recounted are subjected to a chemical scrutiny that is a certain safeguard against fraud and adulteration; how the sanitary condition of railroad stations and cars is attended to through the administration of the chemical department,—was all made clear to the inquiring public.

In a period antedating all historical records some one discovered that silicic acid, as it exists in flints and in sand, when fused with certain metallic oxids, cooled into a transparent solid. There s no reason to suppose that this chemical operation—the forma-

tion of a silicate by the union of silicic acid with an alkaline base—was really understood for thousands of years after the discovery of glass. The terms "acid" and "base," in their chemical significations, are of modern application; yet who shall tell the enormous influence on the progress of the human race that the discovery of the manufacture of glass has effected? Let us say nothing of the invaluable uses of this material in all departments of experimental science, in astronomical research, in the domestic arts, but come at once to what it has done for engineering. The telescope of the theodolite and transit; the mirror of the heliostat and the sextant of the mariner; the tubes of the manometer, mercury gage, mountain barometer, and thermometer; the water-gage of the steam-boiler; the lenses of lighthouses, the microscope, and so on to the end of the chapter, not overlooking insulators for telegraph wires and other electrical apparatus,—where would have been our progress in modern engineering if the world had been until now without glass?

How could we have contrived to handle, on the great commercial scale in which they now enter into the world's traffic, such substances as sulphuric acid, nitric acid, and other articles in common use and universal utility, without glass, the only cheap substance that will securely hold these corrosive materials and long resist their chemical action? And but for the supply of these powerful acids, and the long list of compounds made through their reactions, where would have been the engineering arts of mining, metallurgy, and rock-blasting? If General Newton, of the United States Engineer Corps, had been obliged to depend upon the old blasting-powder in excavating the channel of Hell Gate, the expense of that great work doubtless would have forever inhibited it. With sulphuric and nitric acids and glycerine, nitroglycerine has been produced by the art of the chemist, and this has put into the hands of the civil engineer and the military engineer a force to which the gunpowder of ancient times is a mere pigmy in comparison. An explosion of this material on the very day when the words of this sentence were penned, and at a distance from San Francisco at which the report of a gunpowder explosion would scarcely have been heard, wrecked that city more than a day's bombardment such as that to which, in the siege of Namur by William of Orange, that fortress, strengthened by the successive skill of Cohorn and Vauban, was subjected. This celebrated stronghold would have been a mere egg-shell to modern engineer-

ing resources, so ample have these become through the coöperative aid of the chemical arts.

The ancient process of tanning leather is, in all its essentials, a chemical operation. The use of leather in the one article of belting has been an element in the progress of mechanical engineering important beyond all estimate. Yet scarcely, if at all, inferior in importance, as regards its effects upon the advancement of all mechanical arts, has been the discovery of the useful properties of caoutchouc combined with sulphur.

In honor of the discovery and the discoverer of America the present year is about to be celebrated by a great exposition of progress in the city of Chicago. How many will remember that just three centuries after the discovery of America Murdoch made the first application of gas to the illumination of cities? For a century previous it had been known that light could be obtained from the gas produced by heating coal in a retort, but Murdoch first demonstrated the value of the discovery. Ten years later the feasibility of such illumination was proved by a public exhibition; and within the succeeding twenty years four gas companies, with one hundred and twenty-two miles of pipe, existed in the city of London. Little did Murdoch think, however, that he had done more than to supply an improved illuminating agent. It has remained for the last half of the present century to show that the use of gas in engines for the production of motive power is practicable, and for many purposes more economical than the use of steam.

Still less could any one have foreseen that a by-product of the manufacture of illuminating-gas was destined to become an enormous resource in the future of engineering, and that the formerly worthless ammoniacal liquor was to supply the most powerful artificial refrigerating agent ever known to mankind; that the highest engineering skill would be directed to the design of refrigerating machines and apparatus for dealing with it; and that, by its aid, enormous cold warehouses, in which perishable materials could be kept indefinitely, breweries cooled by ammonia, and artificial ice made by its use, would be common and familiar features of the present age.

The refining of petroleum, and the manufacture of lubricating oils therefrom, are not to be overlooked in summing up the debt which engineering owes to chemistry. The animal oils fit for lubrication have been in large measure supplanted by oils ex-

tracted from crude mineral oils which chemists soon discovered to be mixtures of a variety of hydrocarbons that congeal into solids at very different temperatures. The chemical removal of impurities, and the separation and isolation of these hydrocarbons from each other, have given engineers a class of lubricants of previously unknown and highly valuable properties. Most animal oils available for ordinary lubrication become solid at low temperatures, and are therefore extremely difficult to apply in cold weather, such as that to which machinery is subjected in railroading and other outdoor operations. Even if melted by a stove or lamp, they solidify immediately when poured upon a cold metallic surface, or shortly after they have been poured into an oil-cup, and their flow to the surfaces needing to be oiled is thus impeded or wholly stopped. From the mineral oils are obtained by separation such as remain liquid at very low temperatures and are hence now widely used in exposed situations. Combinations or mixtures of such oils either with other mineral oils, or with animal oils, have enabled the chemist to supply lubricants adapted to all situations and purposes, and the saving in power (formerly wasted) by the use of improved lubricants has been a very great addition to the resources of the modern engineer.

The gain in economy of power formerly wasted in friction, however, has not been wholly achieved by improvements in lubricating oils. The study of alloys, many of which are to be considered as definite chemical compounds, has been fruitful of results in the production of metals in which the normal coefficients of friction are much less than in any metals that could be used for bearings of machinery at any earlier period. In the field of alloys, also, a rich harvest has been reaped by engineers in other ways. Metals resistant to the action of acids and to other corrosive agencies, and metals combining great strength with lightness, have been valuable aids to progress in the mechanic arts. The end is not yet, and the imagination is baffled in the attempt to conjecture what benefits may yet come from the study of alloys. Particularly is electrical engineering indebted to this class of compound metals.

To the resources supplied by chemistry, electrical engineering also owes the materials from which are derived a very large part of the electric power now used. People in speaking of electric power are wont to have in mind principally the generation of the electric current from mechanical power, by dynamos; and this transformation is, in itself, so wonderful, so extensive, and yet so

new that it overshadows the countless smaller applications of electric power in which the electric current is supplied by chemical reaction in electric batteries. But solely by this means, for a long time, the current for operating telegraph instruments was furnished. By electricity derived from batteries millions of diminutive motors are driven to-day, and this original method of obtaining electric power not only continues to be in active demand, but the demand is increasing. Electricity as generated in "storage batteries," "storage cells," "secondary batteries," or "electrical accumulators," as they are variously styled, is regarded by many as likely to assume an even greater importance in the future.

Combustion is purely a chemical process. Its study, primarily by chemists, in developing the conditions under which it can be conducted most economically, has taught engineers how the enormous deposits of carbon in the crust of the earth could be employed profitably to do the bulk of the world's transportation and to supply a large and ever-increasing amount of power to manufacturing plants. When Priestley discovered oxygen in 1774, while delving with rude appliances in the rich but scarcely opened mines of science, he little thought of what immense value the clue he had furnished would prove in guiding the investigators who would succeed him into an understanding of the quantitative character of combustion. It was not until 1807 that the law of multiple proportions in chemical combination was advanced by Dalton; so it may be said that not until the beginning of this century was a true theory of combustion even possible. When it became known that a definite weight of carbon requires for its combustion a definite weight of oxygen; that other constituents of coal likewise demand different but still definite weights of oxygen to convert them into gaseous products; and that atmospheric air contains, in a given weight, a definite weight of oxygen mixed with a definite weight of nitrogen,—the data thus furnished by chemistry for a true theory of economical combustion were seized upon by engineers. They have been used since to formulate principles for the construction of all kinds of furnaces used in human industry, the results being an enormous saving in the industrial use of fuel, as well as the acquisition of the power to generate and maintain high temperatures for metallurgic and other purposes with absolute certainty. Thus the mastery of the engineer over refractory materials has greatly increased.

The art of making bricks and tiles rests upon a purely chemical foundation, and in modern times has been greatly helped by the knowledge of the chemical constituents of clays. In this art, which supplies to engineering one of its most important materials, the means of examining the exact composition of crude materials, as well as manufactured products, has been supplied by chemistry.

The influence upon modern material progress of the chemical analysis of materials is simply beyond estimate. Not only has it enabled the metallurgist to see his way clearly through "mists that darkened all the way" of our forefathers, but it has added to the stock of materials formerly known a multitude of new ones.

This age has been called, not inappropriately, "the age of steel." The future historian, in writing the story of our own era, doubtless will refer to the ancient knowledge of iron-working,—the time when

> Old Tubal Cain was a man of might,
> In the days when the earth was young;
> By the fierce red glare of his furnace bright
> The strokes of his hammer rung.

Tracing the history of metal-working down through the ages, I think that he will date the beginning of the "age of steel" from the introduction of the Bessemer process; and it is certain that the Bessemer process never could have come into the world but for the chemical knowledge that preceded it; and when the process was further advanced and improved by the use of what is known as the "basic lining" in the converters, the supremacy of steel as an industrial metal was assured. What chemistry has done for all departments of metallurgy is far too fruitful a theme to be exhausted here, and only those thoroughly familiar with chemical principles and chemical operations in the treatment of ores and metals are in a position to comprehend the vast possibilities of the future.

The profound influence of chemistry, pervading all departments of industry, is not less conspicuous in the improved cements it has placed at the command of engineering science. This age has not only been called "age of steel"; it has also been named the "artificial-stone age." The introduction of Portland and other cements, which, when mixed with water, solidify into stone by the chemical reaction of their ingredients, and are at the same time strongly adherent to surfaces of natural stone, has given birth to a large and increasing industry in the paving of outdoor walks and the erection of architectural structures.

The art of photography, only rendered possible by the results of chemical investigation and the long list of substances chemistry has supplied within the memory of persons yet living, must not be omitted in this brief review. The facilities it affords for the rapid duplication of plans and drawings; its value as an aid to topographic engineering and the operations of military engineers in the field; the aid it affords in the study of the movements of animals and projectiles,—are all yet undergoing rapid development. Not so much for what it has already done for engineering as its promise for the future is this gift of chemistry to engineering noteworthy.

The latter remark may be applied, broadly and with equal force, to all the industrial applications of the science of chemistry. As the astronomer, gazing through the noblest telescope out into space, through measureless distance, is overwhelmed by the consciousness that space and the star-dust that fills it are absolutely illimitable, and that, though the power of the present aids to vision were multiplied by millions of millions, the same indications of infinite extent would yet appear beyond, so the chemist, standing on the last line of modern discovery, sees no boundary, no limitation of the possibility of discovery.

RELATIVE COST OF GAS AND ELECTRICITY.

By C. J. Russell Humphreys.

THE industry of electric-lighting has reached an age at which it would not be amiss to glance at the question of cost as compared with that of the older illuminant, gas, which we were once told was to be consigned so speedily to the background. At the very threshold of the subject one is struck with what may be called the receptive capacity of the world for new industries. We are told that one gas acts as a vacuum to another, and so it has seemed in the lighting business: though the world has absorbed in a vast amount the newer illuminant known as electricity, it does not follow that the use of gas has decreased to a corresponding degree. On the contrary, more gas has been used, year after year, showing that the world is finding use for a larger amount of artificial light.

A glance at night along the main thoroughfares of any large city will show a vast increase in the amount of light used, as compared with a period twenty years back. Much lighting is done now purely for advertising purposes. It no longer suffices to have a store lighted so that salesmen and customers can find their way around, before, and behind the counters, and stop at that; the whole interior of the shop, and the exterior as well, must be flooded with light, and whether the lighting agent be gas or electricity, it must be of high intensity and in large volume. The effect of this is far-reaching, for the merchant who grows used to bright lights in his store or counting-room insists on having a great deal of light at his home. Nor is this all. In days gone by it would suffice if the streets were lighted with lamps few and far between, but now they must be lighted in the fullest meaning of the term. Again, the tendency in recent years to erect sky-scraping buildings, which shut off the natural light from the smaller edifices and the lower stories of the larger ones, entails the use of vastly increased amounts of artificial light during that portion of the twenty four hours when Old Sol was once supposed to do all the lighting business. Thus it happens that this large receptive capacity of the world for artificial light has led to the building up of a large business for the electric-light corporations, without by any means

snuffing out the older illuminant. In support of this assertion it can be shown that in 1891 the gas companies of Massachusetts made 20 per cent. more gas than in 1889.

This showing is the more remarkable when we consider the business done by the electric-lighting companies of the same State. The figures for 1891 show that the gross receipts of these companies was equal to 45 per cent. of the gross receipts of the gas companies, a statement which is at once a testimonial to the energetic manner in which the electric-lighting business has been pressed, and evidence of the increasing demand for artificial light. To illustrate the latter tendency in another way, it may be shown that in the same State, during 1889, the capacity of the incandescent electric-light companies aggregated 84,400 lights, reduced to the standard sixteen-candle lamps, whereas in 1891 the figures had grown to 183,120 lamps. During the same years the capacity of the arc-light stations increased from 11,529 to 15,338 lamps.

The questions now thrust themselves upon our attention: Is this rapid growth to hold for the future, and how will it affect the sale of gas for lighting purposes? Brushing aside vague generalities, we must admit that the answer depends very largely upon the relative cost of gas and electricity. An element to be considered, perhaps, is whether the electric-light companies have been doing business at unremunerative rates, thus achieving a doubtful prosperity. If we refer to the Report of the Gas Commissioners of Massachusetts for the year 1891 we will see that the interest earned on the capital invested in sixty-one electric-light companies doing business in that State was about 5½ per cent., and at the same time there was charged off for depreciation only about two-thirds of 1 per cent. on the capital stock. It would seem, therefore, that many electric-light companies are doing business for the benefit more of the public than of the stock-holders; doubtless many of these companies are in their present uncomfortable position by reason of mistakes in early construction, or the selection of unfortunate sites for their works, and will in time work out of their difficulties. Such mistakes are inseparable from the starting of any industry. Still, it is well, if any one is inclined to undue elation at the progress made by the electric-light companies in gross earnings and increase in plant, to temper his joy by a calm perusal of the net result, in order that he may not deceive himself.

The question now arises: How can we compare the relative cost of gas and electric light? We must reduce our figures to a com-

mon standard, which will be sixteen-candle light, and then consider the relative amount of capital required in each business per unit of light, and the percentage of gross receipts in each case required to pay the expenses of manufacture and distribution. We may then inquire which light will produce to the company the larger gross revenue per standard of light, which is merely another way of saying whether the public are willing to pay more for one light than the other.

It is safe to say, we think, that the capital required by an electric-light company engaged in central-station lighting—that is, supplying light to a large number of customers from a central station—will approximate $30 per unit of light capacity of the station, or $30 per dynamo capacity of the station reckoned on a basis of a sixteen-candle light.

This, however, does not afford at once an opportunity to compare the relative capital required by the two industries. It is customary to figure the capital in the gas business at so much per thousand feet of gas annually sent out, and when we assume this figure to be $6, we are not yet in a position to make any comparisons, as in one case we have merely the dynamo capacity of the station, and in the other the total output from the gas works. We must, therefore, reduce our figures to the basis of a lamp-hour,—that is, the light of sixteen candles for one hour,—which means, in the case of electricity, that we must determine about how many lamp-hours, on the average, will be sent out by an electric-light station for each sixteen-candle light capacity thereof. And in constructing an average daily load-card, we must remember that up to date it does not seem feasible to store electricity, and that therefore the capacity of the station must be equal (and still have a proper margin for reserve) to the maximum demand for light in any hour,—as for instance during the busy hours of a Saturday evening in winter. A gas-works, with proper storage capacity, can lay up during the week enough gas to meet the heavy requirements of Saturday evening, but not so in the electric station; here the plant must be equal to the maximum call, and further there must be a fair reserve then, for that is just the time that an accident resulting in the shutting off of a portion of the lights of a city would be borne with the poorest grace. So we will assume a reserve of never less than 25 per cent., and on that basis construct a load-card for the average day of the year, thus arriving at the average lamp-hour output per sixteen-candle lamp capacity of the station.

Number of hours.	Output in per cent. of dynamo capacity.	Output per 16 c. p. lamp capacity of station.
One	.45	.45
Three	.25	.75
Two	.10	.20
Eighteen	.05	.90
Total output		2.30

This is an average output per hour, per sixteen-candle-power lamp capacity of station, of $\frac{2.30}{24} = .090$ lamp-hour, which would give us 839.5—or say 840—lamp-hours, per year for each sixteen-candle-power lamp capacity. From this we find the capital required per unit adopted for comparison,—3.6 cents. In the case of gas we will assume that $6 is the capital per thousand feet of yearly output, and that the gas is eighteen-candle power, which would of course be low for New York city, but would hold as a good average, and we find in this case the capital required is 2.6 cents per standard of comparison. In different language, the capital required per sixteen-candle lamp-hour output is as follows:

For electric light ..... 3.6 cents
For gas, on the same basis ..... 2.6 cents

according to which the electric-lighting plant requires 40 per cent. more capital for doing a given amount of business.

When we come to compare the relative cost of manufacture of gas and electricity, and express the same in percentage of gross receipts, we find a further difficulty of comparison from the fact that the gross receipts from electric light per unit lamp-hour are greater than in the case of gas by about 28 per cent.; therefore to compare the cost of the two lights we must make the comparison in percentage of the gross receipts of gas. When we reduce the receipts and expenditures to our common standard,—a sixteen-candle lamp-hour,—and express the relative cost of the two systems in percentage of gas gross earnings, we find the following result:

Cost of gas in percentage of gross earnings ..... 71 per cent.
Cost of electric light in percentage of gross earnings of gas from equal unit of light ..... 91 per cent.

or, otherwise expressed, the unit of light costs by electricity 20 per cent. more than by gas.

We thus find that in order to obtain the unit of light from gas

or electricity we must invest 40 per cent. more capital in the electric business than in gas, and the cost of making the unit of light will cost by electricity 20 per cent. more than by gas, as expressed in percentage of gross receipts of the latter. And, as the earning of a 6-per-cent. dividend on the capital invested requires in the case of gas an amount equal to 26 per cent. of the gross earnings, and as the capital required in the electric business per unit of light is 40 per cent. greater than in the gas industry, it follows that in order to obtain a profitable investment from the electric business we must obtain for a dividend an amount equal to 36 per cent. of the gross earnings from gas. That is if A = gross receipts from gas per unit of light, then we must obtain for electric light: $(A+91\%)+(A+36\%)$ or 127 per cent. of the price of gas, which simply means that, if gas sells for $1 per thousand feet, the selling price of electricity for an equivalent light must be $1.25.

That this is the practical result so far is evident from the fact that, as before noted, the receipts from electricity per unit of light are about 28 per cent. greater than from gas.

It avails nothing to say that this statement is disproved by the operation of electric companies in certain cities, where they are selling electricity at the same price as gas and paying dividends, for we are not concerned with individual cases, but dealing with average results. Such exceptions to the rule might be explained by an abnormally high price for gas in those cities, or by the fact that the electric companies have confined their operations to the thickly-settled portions of the cities and have taken only the best-paying customers,—those of long-burning hours. But these cases offer no suitable basis for comparisons.

We have based our figures on a sixteen-candle-power unit, not forgetting the claim of the advocates of gas-lighting that what purports to be a sixteen-candle electric light fails to net the consumer any such amount of illumination, because the incandescent lamp falls off in efficiency so soon. While conscious of this fact, we have disregarded it in our calculations because we are dealing with comparative results. Besides, this loss is pretty well balanced by that which the gas-consumer suffers from poor burners; the loss in efficiency in the former case may be more rapid than in the latter, but as it is darkest before dawn, so the incandescent, as it approaches its period of lowest results, nears the time when it will be replaced by a new lamp, thus giving the customer the dawn of better things in the shape of the original strength of the incan-

descent. But the gas customer, while perhaps suffering a lesser proportional loss through a defective gas-burner, is apt, through ignorance of his loss, to bear it for a longer period of time ; hence these losses may be held to balance each other.

The electrician may say that the results here noted have been reached with small dynamos and single-cylinder engines, entailing a large expenditure of capital per unit of light and a high running cost, and that in future we will have machines of greater economy. True, we have based our figures on results obtained, and not on the hopes of the future, but this must perforce be the case, for were we to temper our figures by the possibilities of the future in the case of electricity, it would be necessary to do the same with gas-lighting. We are trying to deal with facts, not prophecies. We are not unmindful of the economies offered by the new and large dynamos, wherein two dynamos are connected directly on one foundation with a triple-expansion engine ; we realize the economy that may result in capital account and in daily running expenses ; but we also have before us the improved results which are flowing from the combination of coal- and water-gas, wherein the residuals of the one system are converted into gas by the other. Nor is our vision stopped by the view of the inclined gas-retort, allowing the coke from the coal-gas system to fall by gravity into the water-gas generator, thus reducing labor account to the minimum, but we see the coal dumped by mechanical means into huge retorts in which first the coal is deprived of its volatile constituents by carbonization, and then by the changing of a few valves the retort becomes a generator and the residual coke is converted into carbonic-oxid and hydrogen gases with practically no labor.

If we are to discount the future and figure on the possibilities of reducing the cost of electricity by improvements in the steam-engine, then we must consider also the possibilities before the gas engineer in converting the energy of the gas into light, remembering that by our present wasteful method of burning gas we actually utilize a scant 8 per cent. of the energy of the gas, the balance passing off as low heat-rays.

For these reasons we confine our observations to the present and leave the future to care for itself, remembering that both gas and electricity have their inception in the coal-pile, that both systems waste a large amount of that precious energy, that both schemes of lighting offer great rewards to those who will reduce

this waste, and that in the long run that system will predominate which gives out in the form of light the greatest percentage of the energy of that substance we all regard with such indifference, but which future generations will husband, guard, and protect with such jealous care,—coal.

THE MISSISSIPPI PROBLEM UP TO DATE.

By William Starling,

Chief Engineer Mississippi Levee District.

IN devising plans for the improvement of the Mississippi, or in passing judgment upon plans already devised, one fact above all others to be constantly kept in mind is that the Mississippi is preëminently a silt-bearing stream. If this be kept conspicuously in view, things that appear paradoxes will explain themselves easily and naturally. Fancied analogies, derived from tubs or troughs or clear streams, are certain to be deceptive; the Mississippi is not only a river of water, but a RIVER OF MUD.

It may be said that the whole problem of the improvement of the Mississippi depends on the law which governs the suspension of heavy solid matters in a liquid. Unfortunately, we do not know this law with any accuracy. It is generally admitted that the suspending power is in some manner connected with velocity, but the nature of the relation between the two has never been satisfactorily shown. Mr. Eads maintained that the capacity for retaining matter in suspension varied as the square of the velocity, doubtless basing his belief on an analogy between suspending power and energy or work, or perhaps considering the two as identical. This idea has never been accepted by engineers or physicists. We must rest content with the indefinite assertion that the greater the velocity the greater the amount of sediment that can be carried in suspension. It is not even generally agreed what is the nature of the force which holds the particles suspended. By some it is ascribed to the different velocities of two adjacent horizontal fillets acting upon the sides of the solid particles. It is more generally believed to be due to vertical currents. It is certainly very largely dependent upon the more or less minute state of division of the particles, as it is easily shown that the force required to hold up a solid body decreases rapidly with the size of the body, being in direct relation with the ratio between surface and volume. It is more or less analogous to the force required to hold motes floating in the air. Each minute fragment of dust weighs perhaps 1600 times as much as an equal volume of air, yet it is easily sustained by an imperceptible current, while a large stone of no greater specific gravity

would require a hurricane to move it. In water very small particles might be held in suspension for a considerable time by the mere viscosity of the liquid. Hence arises a discrimination between different classes of sediment, as between sand and clay, which is of great practical importance.

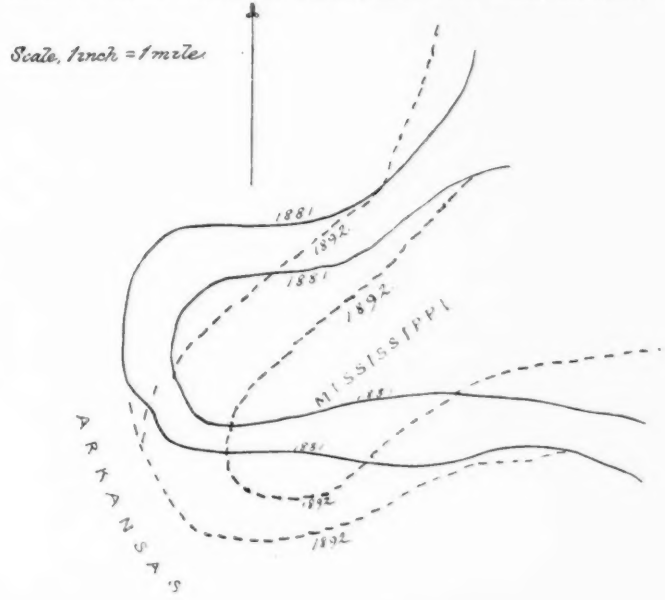
Mr. Eads also maintained that the water of a sedimentary river was always charged to the full extent permitted by the velocity. With his wonted earnestness and pertinacity, he pushed this doctrine to extremes, and drew from it conclusions that were thought repugnant to reason and experience. Therefore some excellent engineers have been at considerable pains to prove Mr. Eads's position wrong. Nevertheless, it is not easy to escape his conclusion; and it can be shown that it does not carry with it any absurd consequences, provided it be rightly understood.

It is well known that a sedimentary river, flowing through its completed flood-plain, has such a slope as suffices to carry to the sea its burden of sediment, without increase or diminution. If the plain be too flat for this purpose, then a deposition of sediment must necessarily take place, until the slope becomes so steep that it will deposit no more. Should the plain be too steep, the great velocity thus generated will give a formidable erosive power, and will cause the river to make lateral excursions or "bends," until the slope becomes so gentle that it no longer erodes. These statements must be understood only in a general sense. In a great river, though its flood-plain be fully developed, erosion may be constantly going on in the concave bends. This process would lengthen its course were it not for the occasional occurrence of cut-offs. Should its course, however, be thus unduly lengthened and no cut-off occur, then a deposit would take place as before, and the slope be steepened again. The river, then, will never be in a state of exact equilibrium.

If it be conceded that the velocity of a sedimentary stream and the stability of its banks are in equilibrium, then it follows that such a stream is loaded with sediment, roughly speaking, to its full capacity throughout its course. If it were not, it would acquire a full load, or more, at the very first "caving bank" that it encountered; and it would continue to carry this, or as much of it as the velocity would allow, until a slackening of the current caused a deposit. This deposit would be only the excess over the load due to the reduced velocity. At the next bend the same thing would occur, and so on indefinitely. But this statement must be under-

stood only in the grand mean. The stream is loaded indeed with all that it can *permanently* transport from the head of the alluvial basin to its mouth, but at various individual points it may be overcharged or undercharged to an unknown extent. Mr. Eads was so convinced of the truth of his postulate that he would allow no exception to it. Yet it is evident that this eminent engineer pushed his doctrine too far; for he claimed that angle of presentation had nothing to do with the matter,—that a river "saturated," as he expressed it, with sediment could by no process acquire any more. Now it is obvious that a stream, flowing with a high velocity, though heavily loaded, even to the point of so-called saturation, coming into contact with a friable bank at an abrupt angle, will dislodge a portion of it. The effect is purely mechanical, and is independent of the condition of the water that produces it, provided only that the fluidity of the latter be not materially impaired.

The dislodged material will not drop to the bottom at once. Water that is "saturated," in a permanent sense, will yet carry a temporary load for a short distance. Perhaps it may carry several times its normal burden for a few feet or a few miles, dropping it



then, even though there be no check to the velocity. It is certain to leave it at the next shoal, where velocity is reduced. Part of it goes to form the shoal, and part flows over the sand-bar which exists under the apex of all "points," building up and building out the latter on the down-stream side, and compensating for the loss which the same point may be suffering from erosion on the upper side. Thus it happened that "points" in a few years have been bodily shifted in position by nearly their whole breadth.*

The quantity of sediment that passes the mouth of the river ought to be the same that enters the head of the alluvial basin, unless changes of regimen have occurred in the meantime. It is probably not identically the same matter. The stream has picked up and dropped loads a hundred times. Part of the Missouri mud has no doubt found a lodgment on some bar, and the silt which is at length dropped into the Gulf is partially derived from the lower bends. That some portion of the original sediment which passed Cairo passes out at New Orleans seems probable from the fact that the proportion of sediment at Carrollton, near New Orleans, is much greater during floods from the Missouri than at other times.

Measures of sediment have been made at Columbus, Fulton, Memphis, Natchez, and Carrollton, but in different years, different months, and under different circumstances; and they are discrepant enough. Of two sides of a river, at the same moment, one is acquiring and the other depositing, and one may be twice or thrice as muddy as the other. Did the reader ever see a muddy stream discharge into a clear one? They do not form a homogeneous river. The mud does not even keep together, but forms detached, circular, curdling eddies, with clear spaces between. This phenomenon occurs more or less all along the Mississippi. Eddies, or "boils" of extraordinary turbidity, thick as chocolate, alternate with comparatively clear portions. Sediment-observations, therefore, unless taken with extreme care, may be valueless and even misleading.

Humphreys and Abbot have given a summary of all the sediment observations known in their time, from Cairo to the Gulf. At Columbus, twenty-one miles below Cairo, from March to November, 1858, the highest proportion was 1 to 670, the lowest 1 to 7152, and the mean 1 to 1321. At Memphis, in 1849, during three months

* See the accompanying diagram, which shows the changes in the point called "Sarah's Island" from 1880 to 1892.

of flood from the Missouri, the proportion was 1 to 596. During 12 months of 1850–51, it was 1 to 1553. At Carrollton, in 1851, the proportions were 1 to 681, 6383, and 1808. In 1852–53 they were 1 to 572, 8584, and 1449. These measurements show nothing conclusively, but as far as they go they indicate that there was no considerable difference between the quantities carried at the head and the foot of the alluvial basin.

There are two classes of deposits in the river-bed,—permanent and temporary. Should a river enter the head of its alluvial basin with more sediment than it carries out at its mouth, the excess must be deposited in its bed, if it be confined between its banks. If it be not so confined, a portion of the excess will be carried over the banks and deposited on the adjacent flood-plain, the other portion being left in the bed as before. This is a permanent deposit. If the current erode a quantity of earth from a caving bend above and drop the same on a bar or shoal below, without increase or diminution, this is a temporary or local deposit, and neither adds to nor subtracts from the entire capacity of the river. Where the erosion occurs, there is a "making" or growing bank on the other side, which preserves the area of the cross-section nearly constant. Conversely, where there is a bar forming by accretion, there is a receding bank on the opposite side. Where there is a shoal or crossing at the reversion-points between bends, there is a wider cross-section at high water, which is increased in depth by scour as the river falls, the scoured material being deposited in the pool below. Therefore, temporary fills in the bed do not act to raise it at all, but merely to shift the channel from right to left, or the contrary.*

Judging from the recent practise of the Mississippi River Commission, their primary object is fixation of the bank, without which improvement of any kind is temporary and illusory. The caving and its accompanying "advance of bars" down-stream will in a short time utterly nullify any attempts at regularization, or keep the works in a perpetual state of transition, mutation, destruction, repair, and extension. Bank-protection not only affords a stable base from which to operate, but it also corrects, in a great measure, the very evils which otherwise would demand contraction-works. If it be true (and I believe it is not denied) that the materials for shoals and bars is supplied from the caving bend immediately above, then the prevention of that caving will arrest the formation of the bar. In very deep and regular bends, where on that account

* See the plate previously given.

the caving is small, there are no bad bars. Not only so, but the holding of the bank gives a permanent "set" or direction to the current, thus preventing the shifting of the channel, which is a continual hindrance to navigation. In short, it is believed by many river engineers that the prevention of caving will do away with the necessity of contraction-works.

That improvement of the Mississippi which has attracted most attention is the protection against floods, and this seems especially to have assumed an interesting phase recently, judging from the number of articles on the subject which have appeared in this Magazine. It is well-beaten ground to the Mississippi engineer. It is investigated about every two years by Congress, and the periodicals teem with papers on it during and after every great flood. There is no way to give novelty to the discussion. However, the audience is constantly changing. The literature connected with it is extensive and interesting, and in particular the reports of the Burrows committee of 1883, of the Logan committee of the same year, of the Paddock committee in 1888, and of the Frye committee in 1890, are valuable repositories of information relative to the Mississippi such as can be gained from no other sources.

The only means which has ever been given a thorough trial for the reclamation of the bottom-lands of the Mississippi is the levee system, but several other schemes have been proposed, all of which have had their advocates. It has been proposed to restrain the principal tributaries at their head-waters, by reservoirs; to divert some of them altogether, and prevent their floods from reaching the Mississippi; to make outlets for the purpose of drawing off the superfluous flood waters; and to shorten the course of the river by cut-offs, thus giving the water a steeper pitch, voiding it with greater celerity, and relieving the river of excessive height.

The reservoir system does not now command any considerable support. Major Powell is rather inclined to favor it, on grounds based upon his theory of corrasion, as he terms it. The system is confined, in its application, to the upper or mountainous portions of streams, for nowhere else could locations be found for the extensive artificial lakes demanded by the project. The scheme has not received a detailed examination. It has never had any prominent enthusiastic advocate except Colonel Ellet, and the only careful investigations he made had reference primarily to making the upper Ohio navigable. He thought it applicable to floods in the

Mississippi, but had no data from which to make accurate estimates. He maintained that to diminish the flood-height of the Mississippi one foot for sixty days nine reservoirs would be required, each of a superficies of seven square miles and of a depth of 110 feet.* This estimate was made on the assumption that a reduction of the discharge of 35,000 cubic feet per second would lower the height of the river one foot. It is more likely that 100,000 feet per second would have to be withdrawn from the upper waters to bring about this effect in the lower river at extreme flood, thus requiring about twenty-six reservoirs. The Quaker Bridge dam will create a lake of about six square miles in area and of 100 feet in depth. At this rate, Colonel Ellet's reservoirs would cost about $120,000,000 for a reduction of one foot in the height of floods.

The effect which would be produced by a system of cut-offs is best to be estimated from our experience with cut-offs occurring from natural causes. They immediately produce a shortening of the distance, a great acceleration of velocity, and rapid and violent "caving" for a considerable distance above and below them. This process continues until the river has regained approximately its former length and slope, being those which were required to bring the velocity into equilibrium with the stability of the banks. In the meantime, the work of destruction and building is going on at excessive rates, and the already too great instability of the river is enormously increased. Should this process be restrained through the reach affected, by revetment, the ultimate result would probably be a very deep pool through the revetted part, with a rapid fall at each end, where the caving would recommence, and continue as before, until the old length was reached. Therefore the revetment would have to be continued indefinitely. If the system were extended as far as Cairo, we should there have a cataract about 200 feet high. Since the cut-off at Vicksburg, in 1786, which saved about six miles of length, the river has, in the 100 miles immediately adjacent, above and below, regained about four.

The most plausible expedient that presents itself for getting rid of water, when it is too high, is to let it out, and hence the scheme which finds the most favor with the natural and unregenerate man is the "outlet plan." It seems to commend itself particularly to steamboatmen. Under this plan are embraced several designs, not incompatible with each other. These are lateral out-

* Ellet on the Mississippi and Ohio (edition of 1853), p. 219.

lets, diversion of tributaries, and a terminal outlet or shorter course to the sea, opened at a moderate distance above the Head of the Passes.

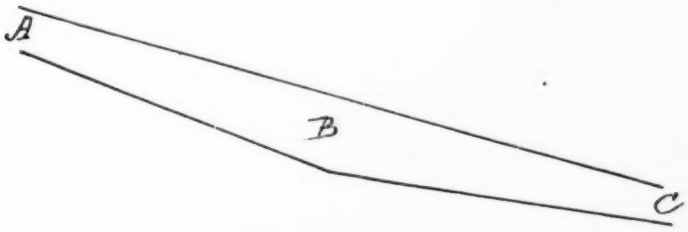
For carrying into effect a system of lateral outlets several devices have been proposed Colonel Ellet's idea was to make use of the natural water courses, like the Atchafalaya, the Lafourche, and the Plaquemine, as auxiliary to his grand terminal outlet at Lake Borgne, below New Orleans. He did not favor outlets on the eastern side above New Orleans, leading, as they all would do, into the shallow waters of Lake Pontchartrain. Above Baton Rouge any system of lateral outlets must be confined to the western side of the river. The Mississippi side is all hemmed in by hills, including the head and foot of the Yazoo Basin, and it would answer no good purpose to let the overflow water into this bottom to be returned at Vicksburg. The possible diversion of the Arkansas was also comprehended in Colonel Ellet's plan.

Professor J. B. Johnson* proposed to construct waste weirs at suitable points, and conduct the outflow through natural reservoirs and channels, which he would clear and improve for that purpose. He estimated that half of the lands in the Mississippi bottom were irreclaimable, and might be sacrificed to furnish drainage for the waters discharged over the weirs. I think that none of these plans entered into details or presented any estimates of cost or damage, —and indeed it is pretty certain that no well-matured design of lateral outlets has ever been submitted. The objections which have been made to this plan are principally three. First, that the relief would be mostly local ; second, that it would be only temporary ; and third, that it would be bought at too great a cost.

The effect of an outlet or waste-weir is greatest at the point where it is situated, and becomes rapidly less as we progress upward, until it is lost altogether. The effect below is more far-reaching, but it is never so great as at the point of occurrence. This is easily shown by reference to the accompanying diagram :

Let *A C* be the slope of a confined stream. Let an outlet be made in the levee at *B*, depressing the flood-line at that point by one foot. This steepens the slope, increases the velocity, and lowers the flood-line at *A*. It cannot, however, lower it by so much as one foot. If it did, it would restore the slope to what it was before, and the reduced cross-section would not be sufficient to

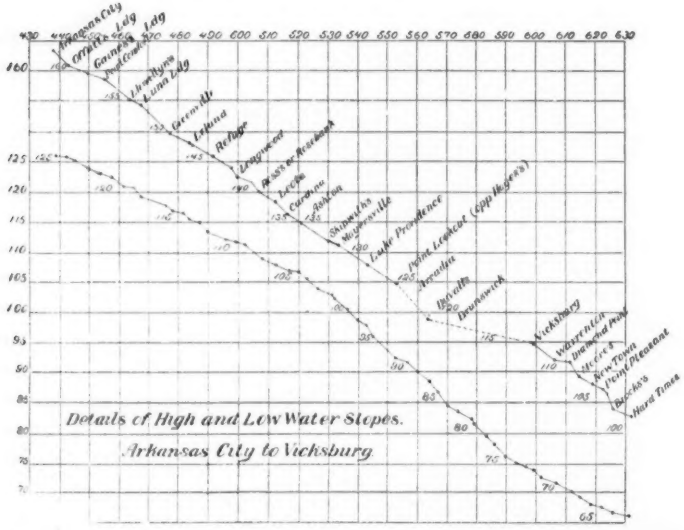
* See his paper in the "Journal of the Association of Engineering Societies" for July, 1884. This is the ablest defense of the "outlet theory" that I have seen.—W. S.



pass the discharge. At the point *C* the discharge has been diminished by the volume which has escaped through the outlet. Therefore the velocity has been lessened, and for that reason the height will not be proportionally decreased.

This reasoning is abundantly supported by evidence. A crevasse occurred in 1892 at Panther Forest, Arkansas, discharging at the highest point about 90,000 cubic feet and lowering the river at that point presumably about one foot. The effect produced at Arkansas City, thirteen miles above, was estimated at three-tenths of a foot. At Greenville, twenty-seven miles below, it was six-tenths. At Vicksburg, 148 miles below, it was about three- or four-tenths. It would appear then that the effect of a waste-weir is greatest *below* it, is comparatively insignificant above, and is nowhere so great as at the point of occurrence. The relief therefore is largely local. Colonel Ellet seems to have been aware of this fact, for he intended his outlet scheme to apply only to the region south of Red river.

The subtraction of a large volume of water from a silt-bearing stream diminishes the transporting power of that stream by lessening the velocity. Velocity depends partly on volume, and a reduction of the cross-section immediately induces loss of velocity. If a river flowing at a rate of 6 feet per second have its velocity reduced to 5.5 feet, it will not be able to carry the load which it has in suspension, but will drop a portion of it. The experience with outlets of any kind, natural or artificial, is that they bring about a gradual deterioration of the bed of the stream by raising it, and thus ultimately defeat their own object. As an illustration of this fact, the upper part of the Tensas Basin, from Arkansas City to Ashton, in Louisiana, remained almost without levees for about twenty-five years. An accompanying plate shows a profile of the high- and low-water lines opposite to this basin, the latter of which conforms pretty closely to the shape of the bottom. It



shows a convexity increasing in proportion to the quantity of water which escaped over the bank, and diminishing as the discharge was restored by the return flow from the Yazoo Basin above Vicksburg.

Outlets have been given a fair trial in Holland, where they were once the fashion. They are now utterly condemned, for reasons which will best be given in the words of well-known Dutch engineers, in response to queries addressed to them on this very point. One says: "The outlets were dangerous and detrimental on two grounds. First, they caused a slackening of the current and consequently deposits and shallowing; and second, by the same slackening the movement of ice was impeded and gorges formed." Says another: "Formerly along all our large rivers we found such outlets, which were made to allow the water to escape sideward, especially by an ice-gorge. This system is out of practice at present, as it is stated to be *no good at all.* The river must be capable to carry off its own water. . . . . The outlets are filled up to height of the dikes, and at present only two more exist, and they will soon disappear."

That outlets would render useless a great quantity of valuable land is admitted by all, but their advocates consider this a necessary evil. Professor Johnson's estimate of one-half of the bottom lands

as being irreclaimable is largely exaggerated. There is really very little waste land in the Mississippi valley. Owing to the beautiful natural system of drainage, by which the ground slopes away from the main river to the principal tributary of each basin, almost all the land can be cultivated with profit, and a vast additional area is being cleared every year. To sacrifice half the lands of the Yazoo Basin—or say 3000 square miles—would entail a loss of $10,000,000, even at the lowest valuation of lands. The only alternative to this wholesale abandonment seems to be the leveeing of the outlets. This is a gigantic undertaking, as it costs nearly as much to levee a small stream as a large one. For these reasons the system of lateral outlets is deemed unadvisable by those best acquainted with the Mississippi.

The scheme of a great terminal outlet, higher up than the present mouth, and bringing the river into closer communication with the sea, reducing the water-level at New Orleans and consequently above, has been brought prominently into notice more than once, and extravagant expectations have been based upon it. As has been seen, it was the grand reliance of Colonel Ellet for the country below Red river, but others have not been so modest in their claims. Mr. Clarence N. Dutton, writing in THE ENGINEERING MAGAZINE for August, expects a reduction of the water-line at Cairo of thirty-six feet, and I think that Captain Cowdon looks for some such result.

Allusion has already been made to the extremely localized effect of weirs or outlets in the case of small lateral crevasses. The effect in the case of a very great crevasse near the mouth was well shown in the instance of the Nita break in 1890, which discharged a volume estimated at between 300,000 and 400,000 feet per second. The influence of this outlet upon the height of the river at College Point, four miles below, was estimated at 3.5 feet; at Carrollton, fifty-eight miles below, at 2.15 feet; at Bayou Sara, 100 miles above, at 0.2 foot; while at Red River Landing, 134 miles above, it was absolutely null.* In a river with a fixed bottom, this condition would be permanent. With a movable bottom, of course the great steepening of local slope thus induced would result in increased velocity and destructive activity,—in short, in violent caving, until equilibrium was restored, as in the case of a cut-off. The outlet itself would not remain stationary. It would form a delta, which would probably eventually close the opening;

*See Colonel Suter's report, in the Report of the Mississippi River Commission for 1891.

otherwise a permanent channel would be excavated through it for the river, in which event doubtless this would become the main arm, the old channel being gradually deteriorated. In view of the fact that the present condition is highly satisfactory, so far as navigation is concerned, it would seem folly to invite such a state of chaos in its place.

The project of the diversion of the Arkansas has never been seriously considered. In general, the preparation for a large river of a new channel other than that which nature has chosen, with slopes and banks altogether different from those now provided for it, is an undertaking of such magnitude and difficulty that the task of proving its practicability may well be devolved upon those who propose it. The diversion of the Atchafalaya, an entirely different question, is now under discussion, and very diverse opinions are entertained about it among distinguished engineers.

The levee system, which is the one now in vogue, has been objected to on several grounds: that it was very costly; that it was very dangerous; and that it exposed the river to deterioration from the confinement of silt, causing the deposition of the latter in the bed of the stream.

Many extravagant statements have been made about the amounts already expended for levees. According to the testimony taken by the Frye committee there had been spent, from 1865 to 1890, by the States about $22,000,000, and by the United States about $3,000,000. What had been spent before 1865 is not known certainly, but as the system only began in earnest in 1859 and soon came to a close with the Civil War, it is likely that the amount was not great. Up to the present it is probable that $35,000,000 will cover it. The Mississippi River Commission have made an allotment of $6,000,000, to be spent in four years, which will probably be supplemented by $4,000,000 from local sources. It is likely that a similar amount will be required to build the levees to the dimensions now considered as sufficient,—namely five feet above the highest recorded floods. These sums are considerable, but they seem small in comparison with those required for reservoirs or even for lateral outlets. It may be remarked that the system is approaching completeness so rapidly that it is possible to make pretty close approximations to actual cost.

There is no difficulty in making levees that will be secure against disaster. The accidents that have happened in the past have not been due to any miscalculations or to misplaced economy,

but simply to want of money. The maintenance of a long line of levees is a severe strain upon local resources, in a sparsely-populated territory, and the existing line, imperfect though it be, is the result of very heavy taxation. The number of accidents is steadily decreasing. Against the levee of the Yazoo Basin of Mississippi, 300 miles long, the flood-line in 1892 was higher than ever before, to the extent in many places of one foot. Nevertheless, there was not a break, and the same is true of the Lower Tensas Front, in Louisiana, 216 miles long.

The idea that levees tend to raise the bed of a stream is one of ancient date, which is still believed in by many persons. It is singular that it should ever have gained credence at all, for it is utterly opposed not only to all sound engineering principles, but also to all testimony. Velocity is lessened by the dispersion of waters over the bank and is conserved or increased by their retention. The part of the water which is discharged over a weir is that part which is most nearly clean. Hence, in wasting it, not only have we weakened the stream and reduced its capacity for its burden, but we have not withdrawn a proportional part of the load. It is true that we have retained the sediment which otherwise would have been carried out into the flood-plain, but we have also retained the vehicle which is to carry it, and in much more than sufficient quantity for that purpose. The evidence on this point as well as the reasoning is very well given by my friend Mr. H. St. L. Coppée, in THE ENGINEERING MAGAZINE for August. The opinion in question is not entertained by any engineer familiar with the Mississippi, whether he be connected with the levee service or not. The members of the Mississippi River Commission are of all shades of opinion as to matters connected with river-improvement, but not one of them believes that confining the waters has any tendency to raise the bed.

Professor Lewis M. Haupt has observed that the engineers connected with the Mississippi service are usually in favor of levees, while those who are more remote from the scene are generally opposed to them; and is inclined, I think, to attribute this bias on the part of the residents to the pressure of public opinion. He might have ascribed it to a more probable reason, namely,—that they are much better acquainted with the conditions of the problem. I venture to say that so good an engineer as Professor Haupt, if he had given the same thought to sedimentary rivers that he has to harbor entrances, would agree with the Mississippi engineers.

THE ELECTRIC MOTOR AND THE FARMER.

By William Nelson Black.

THE electric motor has a political and social side, though it may sound like an eccentric use of language to speak of the political or social features of a machine. But when we remember that the cotton-gin has been held responsible for the American Civil War, and observe that the locomotive seems to have instigated the organization of the Farmers' Alliance, it will be seen at once that the language is entirely consistent. The truth is that all labor-saving machinery and power-producing forces have their social and political influences; and an inquiry into the probable effects of the electric force on the development of our civilization will be quite legitimate. The invention of the electric motor must have great consequences; and we should be exceedingly dull were we not able to forecast them with a considerable degree of accuracy.

The railroads, the chief factors in the unparalleled development of this continent, seem to have been productive of a curious condition of demoralization. More than any other industrial works ever executed or conceived, they have illustrated that power of individual initiative which our Constitution was especially framed to promote, yet they seem to have produced a reactionary spirit even revolutionary in its intensity. In listening to the demand for government control of the railroads, one is almost ready to inquire if the designers of our political system did not lay the foundations of liberty so broadly that they left place among the workmen for the emissaries of political despotism.

Jealousy in part, and in part a distrust of the power of association, lie at the foundation of the hostility to the railroads so broadly manifested. None except a lunatic would maintain that those roads have ever been anything else than an inestimable benefit to the country; and none but an idiot, ignorant of political history and the necessary limitations of political activity where any hope of protecting liberty remains, would ever dream that we could have had a tenth part of the railroad mileage now in operation had it not been constructed by the precise agencies through which it was obtained,—that is to say, under the impulse and inspiration of individual initiative and personal interest and ambition. But the

railroads have been productive, not of the largest, but of some of the largest fortunes in the country, and this has provoked the hostility of men whose own inactivity leaves them too much leisure for the study of social problems. The Peffers are the political offspring of the Vanderbilts and Goulds.

Nevertheless, we cannot afford to give up our constitutional system because it permits a few men, especially capable at money-getting or especially lucky, to become rich, and some other men, especially lucky but of an unmeasured capability, to get into the United States Senate. We shall maintain the system at all hazards until we find a better one along the line upon which we are already moving; and in the meantime we shall insist upon keeping at work all the forces that have served us so well in the past. If the country has become debilitated and full of corrupt blood, as we are taught in political platforms, we shall have perforce to try the old remedy, and trust the hair of the dog to cure the bite. We want more railways, so many more that railway trains or vehicles may be seen smoking along every highway in the country; and the best way to obtain them will be the way approved by experience. We shall in fact settle the argument in favor of our political system by carrying individual initiative to its legitimate conclusions *in the conversion of all roadways into railways.*

Does this seem like a work of startling magnitude? It would have seemed like an impossible undertaking only a few years ago. The railroads now in operation, extending only 170,000 miles, represent such an enormous capitalization, and they have taken so many years in construction, that the imagination falters at the conception of several millions of additional miles. Without reflection, any one could be excused if he pronounced the idea chimerical. But the situation is greatly changed. In the first place the financial science and the art of railroad construction have been highly perfected, and, in the second place, the new source of power in electricity will enable us to put as many railways as we please in operation without mortgaging the future for more than it can comfortably carry. Let us see, then, if the electric motor is not destined to play a great rôle, a rôle of unparalleled grandeur and utility, in the social evolution of the future.

First, let us consider a question of economy. The road-wagons and the short-lived top-buggies and carriages of the farmer cost him a very pretty penny in the course of a year, or a term of years, and they represent a service which the electric railroad can largely

abolish. But against this saving must of course be set the cost of the railroads, the electric power-stations, the rent of electric wagons, and operating expenses. What would be the amount? An accurate estimate cannot of course be made here, because conditions differ so widely in different sections of the country; but as close a calculation as we can make in advance, founded on the cost of the electric railroads already in operation, warrants us in saying that probably 90 per cent. of the roadways in the United States could be equipped with the necessary track, poles, and wires at a cost of $3500 per mile. In a district ten miles square—the surface that could be served from a single central power station—there would be, in the larger part of the Union, about 100 miles of railway. Then the total cost of track for a district ten miles square would be $350,000. This represents a capitalization of only $5 to the acre, and an annual interest charge of only 30 cents per acre. With a central power station large enough to operate all the wagons or cars that would be called into use at one time in a district, the capitalization need not be more than $10 per acre. This would mean an annual interest charge of $60 for each hundred acres of land. It must be conceded that this does not seem like a very heavy tax when we consider the nature of the service rendered available, the great saving in the cost and maintenance of horses and wagons, the enormous economy of time, and the greatly enhanced value of improved farm lands. If the interest charge mounted to $100 per year, and the farmers were themselves chiefly the stock-holders of the electric companies, it would still represent an economy.

Now, what should be the first effect of this suddenly discovered facility for railroad extension on the temper of the farmer? He may think as he pleases about the iniquitous management of the railroads; but the heaviest transportation charges that he is compelled to meet are still made by his horses, his road wagons, equal to the transportation of only a few bushels of grain, and his interminable dirt roads with their annual charges for repairs. If he happens to live at any considerable distance from a market town, it costs him more money to get his grain to the forwarding agent than it costs to get it from the forwarding agent to New York, or possibly even to Liverpool.

Here is where we may look to see the first political influence exerted by the electric motor. When the farmers learn that they can build all the railroads that they need from their own resources, strengthened by legitimate financial methods, we shall hardly ex-

pect to hear them ask that the opportunity to build shall be taken from their hands by the political thimblerigger. We should as soon expect to hear them ask that the fee simple to their farms shall be destroyed, and that they be made tenants at will to some political landlord corresponding to the "elder" of the Russian mir. They will ask for no such foolish thing.

But the transformation of the farmer will not end when he finds himself in the possession of electric railroads and power-stations of sufficient magnitude to drive electric wagons on the highways. Having become a stock-holder, he will begin to look around directly to see how he can increase the dividend-paying quality of his stock, and, at the same time, how he can perform the heavier part of his farm labor more expeditiously, cheaply, and pleasantly than he can perform it by the aid of horses. He will see at once that all that the steam-engine has been trained to do in the West on the great farms can be done by the electric motor everywhere on farms of any size. He will see, also, in the proximity of towns and villages of considerable magnitude, the opportunity to supply manufacturing power and the electric light at a profit. Then he will no longer be satisfied with his railroads and electric wagons, however admirable they may be within themselves; but he will proceed to enlarge his field until farming becomes an elegant diversion rather than an exclusive pursuit. Then the farmer will find himself launched in a new life, demanding what will prove to him a new social philosophy. As soon as he discovers that he can profitably become and remain a stock-holder in a field of investment that he can control, he will return again to those constitutional ideas upon which every farmer of American birth was nurtured, and he will ever after remember his excursion into republican imperialism as a kind of political nightmare. It will thus happen that the political and social effects of the universal distribution of electrical power will be great, so great, finally, that its very contemplation is almost bewildering to the imagination.

Let us consider the effects on the movement of population. It is a source of regret to many persons, and very properly a source of regret, that so large a poportion of the increase in the number of inhabitants indicated by the decennial census is concentrated in the cities. But why do the people throng to the cities in preference to the rural villages? Because they are gregarious, it may be answered. But this would not furnish half an answer, because men are not nearly so gregarious by instinct as some persons imagine. It is a

conviction of the writer that the gregarious instinct in men is restricted to the pairing propensity, and that its further indulgence is inspired by self-interest. The Western pioneer who moves still further west because a new-comer has invaded the five-mile radius of his solitude is as fairly a representative being as the metropolitan dame who gives costly entertainments. The increase in population goes to the cities or to new farming districts chiefly because it cannot go to the old rural districts without pecuniary loss. On account of the lack of resources for transportation it is impossible to pursue successfully any occupation in rural villages that undertakes to serve anything more than merely local demands. It is impossible to drive heavy machinery because it is too expensive to obtain coal; and for the same reason it is impossible to handle raw material or finished product economically. In this fact, and not in the gregarious nature of men, may we look to find the first cause for the disproportioned growth of the cities and large towns located on the line of railroad communication. But when the country has equal facilities for transportation with the cities, and is equally well provided with power, its lower rents will give it an advantage.

There are other causes, however, besides industrial causes that lead to the concentration of population in the cities, the chief of which is found in their superior educational advantages. The city schools are large; they may have accomplished principals and assistants and be graded in a manner suitable for the training of pupils, according to their acquirements. But just such schools will be among the first things that the electric motor will bring to the country. When the electric wagon shoots along all the country roads at a speed of fifteen to twenty miles an hour there will be no need for more than one grammar school in a township, and it may be attended by many hundred pupils. Even a larger concentration than this would be possible were it thought expedient, and the schools of several townships could be concentrated in a single building. This would give opportunity for the largest expenditure for teachers and equipment, and the country would become an ideal place for the training of children. It would be better than the city, for it would be freer from objectionable associations; and many persons who now seek the city as a dwelling place on account of its educational advantages would remove to the country for preference.

Again, many persons make their homes in the cities on account of their superior advantages as to churches. The most accomplished

clergymen are to be found there because the concentration of membership and wealth in single congregations gives the resources for their employment, or for their "call," if they prefer the word. But the country church may rival the city church in wealth and membership when the electric railroad has practically made a radius of ten miles or more a single neighborhood, and the disparity will then disappear. Incidentally, too, a broader, more cosmopolitan, and more highly cultured society will be developed in the rural districts; and this will take from the city one of its chief claims to superiority, and help to check the flow of blood to the now badly congested head of our political body.

But we need not end by calling attention to increased manufacturing resources, improved schools, and enlarged churches, when pointing to the increased attractions which the electric motor will bring to the rural districts. It will bring a general educational advance caused by the freer, broader, and more rapid flow of ideas. Substantially everything—except possibly the very highest institutional achievements in musical, dramatic, and pictorial art—on which the city can now base a claim to superiority will soon be found in the country in about equal perfection.

There is a wide chasm now that separates the country from the city, a chasm not so bloody as the chasm that once separated the South from the North, but broader, and both psychologically and physically more impassable. There has apparently grown up a feeling in the country that the pursuits of the city are inimical to the rural districts, and that the people of the cities are little better than poachers on the preserves of the agriculturists. There no longer seems to be that community of interests, and there is certainly not that community of feeling, which once bound the two segments of society together; and the change is more largely due to changed physical conditions than to anything else. The farmer still plods along in his old furrows, or on his superannuated highways, too often innocent of the beneficial laws of finance; and he seems to be rather blinded than informed by the light which, blazing from financial centers, penetrates into his district with an illuminating power only sufficiently strong to distort. What he needs is something to bring him in harmony with the financial system, and this is precisely the work that may be allotted to the electric motor.

BUSINESS OPPORTUNITIES IN CUBA.

By Eduardo J. Chibas, Civil Engineer.

THE wonderful natural resources of the island of Cuba offer an opening for the profitable investment of capital and for the extension of trade which, until within recent years, has been almost entirely ignored by business men in the United States. Yet the geographical position of this island is such that it would seem that it ought to attract attention of capitalists here first of all among the commercial countries of Latin America. In addition to the point of convenience of location is to be considered the fact that Cuba and the United States each produces commodities, natural or manufactured, which the other needs in large amounts; besides, friendly relations exist between the two peoples. To appreciate properly the opportunities for increased commercial intercourse with Cuba, it will be well first to consider what industries now exist on that island, it being safe to assume that whatever channels for investment have proved profitable to capitalists from other countries may, with the exercise of discretion, prove equally profitable to American investors.

Cuba is an exceedingly fertile island. Its possibilities have long been appreciated by European merchants, who have extended their dealings with the island until, although its area is less than that of the State of New York,* its foreign commerce, according to the latest available statistics, gives it high rank among Latin-American countries. In a recent year (1887) the total of the exports and imports of Cuba reached $127,684,000 †; which was 17 per cent. larger than the foreign commerce of Mexico for the same period, and more than twice as great as the foreign commerce of the five Central American republics combined. In South America, the foreign commerce of Cuba is exceeded in extent only by that of Brazil and Argentina. It exceeds that of Chili and of Uruguay,

*The length of the island of Cuba, following a line through its center, is 730 miles. The narrowest point, a little west of Havana, is twenty-one miles wide, and the widest, in the eastern portion, is 111 miles. The total area is about 43,200 square miles.

† Later statistics are not used in this paper for the reason that information of the character involved here is seldom published by the Spanish Government.—E. J. C.

WAGONS CARRYING SUGAR-CANE TO A FACTORY, PAST DWELLINGS ON A SUGAR ESTATE.

and also the aggregate of the six republics of Colombia, Venezuela, Bolivia, Peru, Ecuador, and Paraguay. Out of the total amount of $127,684,000, about 48 per cent. of this trade was transacted with the United States, which is not a large share, in view of the nearness of the island to the United States and the other facts noted.

The staple product of Cuba is sugar. The production for the current year is estimated at 966,000 tons, or an increase of 18 per cent. over last year's figures of 816,000 tons. Cuba is by far the largest cane-sugar producing country of the world, and the limit has not yet been reached, either in the yield or in the world's demand for cane-sugar. Twenty years ago, when there were more than a thousand plantations on the island, and when the price of sugar was high, the margin of profit was so great that little attention was paid to economy in production or the use of improved machinery. But when success was attained in the manufacture of beet sugar in Europe, competition reduced the price of the Cuban product until many of the small plantations, with their primitive methods, were abandoned, their places being filled by great factories embodying all the improvements that modern science could bring to grinding the cane and extracting sugar from the juice. On a well-regulated sugar estate in Cuba to-day a network of railroads traverses the fields, comprising several thousand acres each, where the cane is cut and placed in cars which are drawn by locomotives to the factories. There it may properly be said that the cane is thrown into the mill at one end and the sugar comes out at the other end, with little or no intermediate handling. The bagasse, or refuse of the cane as it comes from the mill, is conveyed to the furnace and utilized as fuel, which saves a large item of expense.

The sugar factories are usually large iron frame buildings, which, with their contents of machinery, represent an investment of from $200,000 to $1,000,000 or more. Work goes on in them night and day, throughout the grinding season, producing a yield measured by millions of pounds. The great central sugar factory "Constancia," in the neighborhood of Cienfuegos, has turned out in a single year no less than 45,000,000 pounds. This does not embrace the great quantity of molasses and rum that are also a product of the sugar factories. It will readily be seen what an important market is afforded here for sugar-machinery, including boilers and steam-engines, especially as nothing of this kind has yet been produced by native industry. The greater part of the machinery used on these estates comes from England and France,

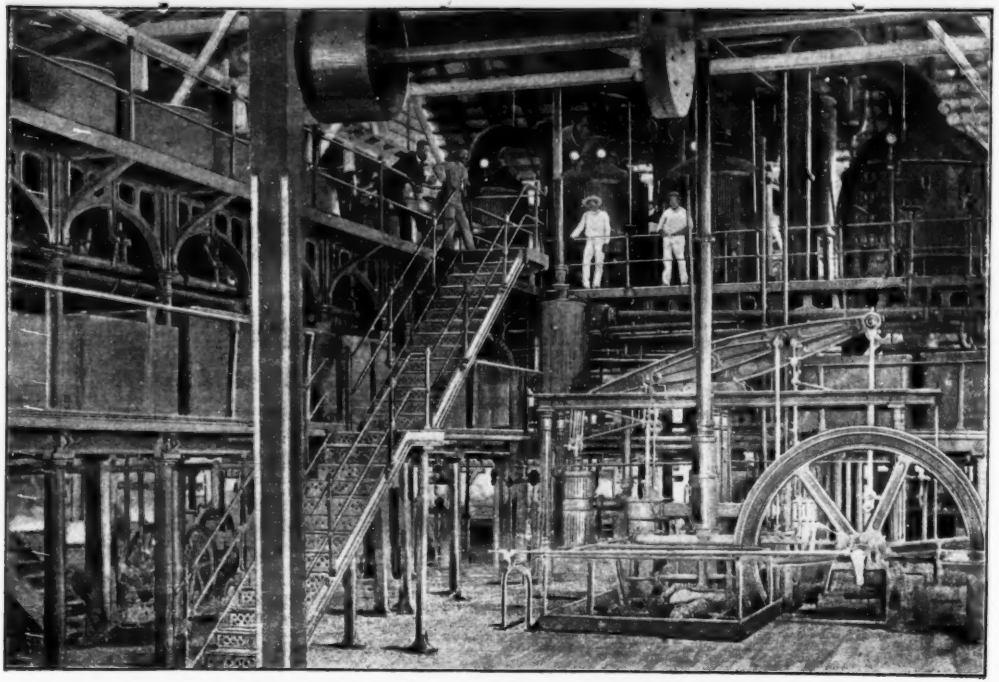
RAILROAD BRIDGE ON THE SOLEDAD SUGAR ESTATE, 392 FEET LONG, BUILT OF OLD RAILS.

though of late American machinery is beginning to be introduced, with results satisfactory to the sugar-manufacturers. More definite figures in regard to such machinery cannot be given than are embraced in the statements of the Bureau of Statistics of the United States. The exports to Cuba of "Iron and steel and manufactures thereof" embrace sugar machinery, and the increase under this heading is shown by the statements of value for the fiscal years ending on June 30, in the following comparison :

For the year 1888-89	$1,257,423
For the year 1889-90	2,709,904
For the year 1890-91	3,120,276
For the year 1891-92	3,431,668

PRIMITIVE METHOD OF TILLING THE SOIL.

This is a showing which will be more satisfactory to patriotic Americans than would be a diminishing comparison, but it by no means represents the extent to which machinery and other iron products might be sold to Cuba were a more energetic canvass made of that market. Formerly the sugar estates were conducted mainly with Cuban capital. The improvement in methods and the introduction of English capital were contemporaneous, and so long

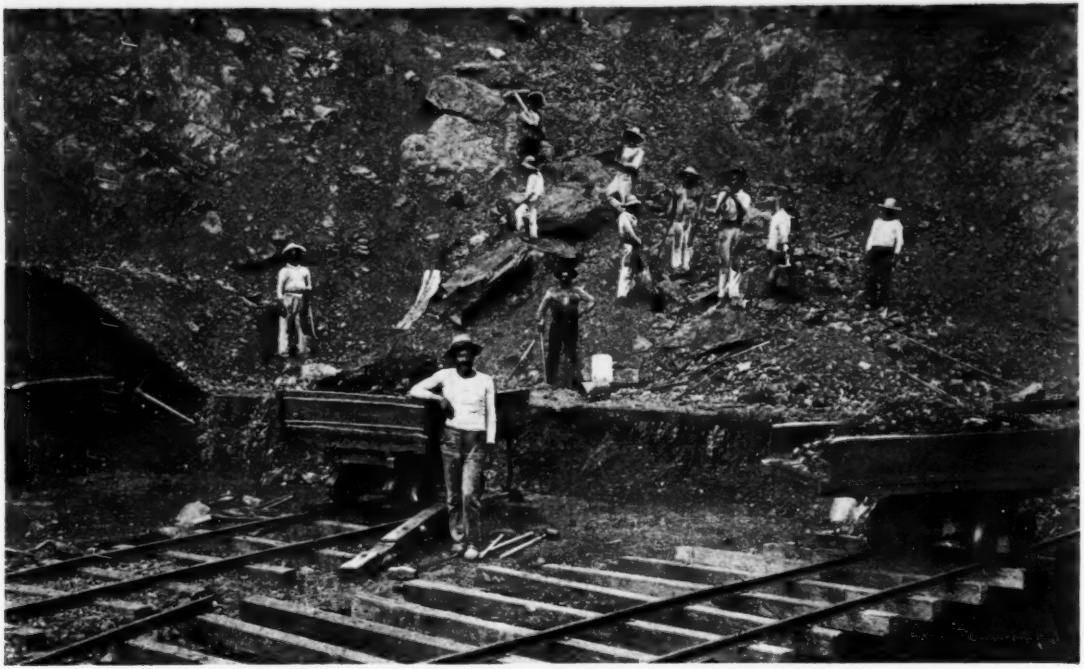


PARTIAL INTERIOR VIEW OF FACTORY OF SAN CÁRLOS SUGAR ESTATE, GUANTÁNAMO, CUBA.

as European capital was largely employed it was only natural, perhaps, that much of the machinery used should be brought from the other side of the Atlantic. Of late, however, capital from the United States is beginning to find employment in the factories, as a result of which it is probable that the sale of manufactures of this country will meet with a greater demand in Cuba, on the sugar estates and elsewhere. At this time an American syndicate with several millions of capital is establishing a sugar plantation and factory in the valley of Trinidad, near the southern coast of Cuba.

JURAGUÁ MINING RAILROAD ASCENDING A 3.6 PER CENT. GRADE.

The soil of Cuba is so well adapted to the cultivation of cane that fields can be shown that have been producing crops for the last twenty years without deterioration in the quality of the product and without the application of any fertilizer. Irrigation has been successfully introduced on some of the sugar estates, but the planters generally have been slow to appreciate the benefits derived from it, and the work progresses slowly. Large tracts of land are still available for sugar cultivation, and that industry is susceptible of further enlargement to an almost indefinite extent. Since Cuba



MINING IRON ORE IN THE JURAGUÁ GROUP—LOADING CARS BY GRAVITY FROM THE HILL-SIDE.

is not a manufacturing country, her dependence upon foreign markets is very great, and in return for the exports of sugar she must take agricultural implements, railroad supplies, electric-light appliances, and all kinds of wood and manufactures thereof, all of which affords an extensive opening for North American traders.

Next to sugar the most important product is tobacco, which is indigenous to Cuba. Although it grows all over the island, it is the tobacco cultivated in Vuelta-Abajo, the region west of Havana, that has gained the world-wide reputation enjoyed by the Cuban product. The export has grown constantly, until at present the yearly production is about 30,000,000 pounds of leaf, a considerable portion of which is turned into cigars at the numerous manufacturing establishments at Havana and elsewhere in the island. There has been a revival of the fruit trade in Cuba during late years, especially in the region of Baracoa, at the eastern extremity of the northern coast. The annual production is 25,000,000 cocoanuts and more than 2,000,000 bunches of bananas. Two cocoanut-oil factories in Baracoa consume yearly about 14,000,000 nuts, and the rest are shipped to the United States. The bananas are conveyed over wire tramways from the plantations to the coast—sometimes for a distance of about five miles—and shipped thence to American ports. On the same coast, west of Baracoa, a new fruit center, named Banes, has lately sprung up, and bids fair to become one of the most important fruit plantations in the world. Four years ago a Cuban firm purchased, at Banes, thirty-five square miles of land, then covered by a dense forest. The work of clearing away the forest was at once begun, and ten miles of a three-foot gage railroad were built. At present they have 10,000 acres of land planted with bananas, with 2,400,000 fruit-bearing trees, and they expect to export to New York during the present year 1,500,000 bunches. Last year they exported 1,300,000. They control nine 700-ton steamers specially constructed for their trade, the newest of which are twin-screw steamers of the latest type.

The cultivation of coffee, which was once a great industry in Cuba, has declined until the production is hardly sufficient to supply the home consumption. The first seeds were brought to Cuba from Santo Domingo by French settlers as early as 1748, and the soil proved to be so well adapted to the cultivation of coffee that in 1860 there were nearly 800 prosperous plantations on the mountain slope rising in the eastern, central, and western parts of the island. In 1869 the shipment of coffee from the two ports of Santiago de

JURAGUÁ MINING CAMP, NEAR SANTIAGO DE CUBA.

Cuba and Guantánamo amounted to 10,112,500 pounds, about 6,000,000 of which were shipped to other ports in the island and the rest to France and Spain. The shipment from the same ports in 1886 amounted only to 1,550,627 pounds. The higher profits to be derived from sugar industry some years ago served to some extent as an inducement for the neglect of the coffee fields; but the change in most cases proved unsatisfactory, and of late years there has been a revival of the coffee and cocoa cultivation, which to-day presents a most enticing field for capital. An advantage in coffee-growing is that a plantation can be started with very moderate

WATER-CARRIER SUPPLYING SUBURBAN RESIDENTS.

capital, and from the time the first half crop is gathered, in the third year, or the first full crop, which comes in the next year, a yearly profit of from at least 25 to over 100 per cent. on the capital invested can be relied upon. The cocoa shrubs are planted to shade the coffee bushes, and when they begin to yield crops, which are slower to appear than coffee, they also become remunerative.

Cuba is very rich in minerals of a great variety. Early in the present century several English companies were organized to

WORKINGMAN'S FAMILY AT THE WORKINGMEN'S QUARTERS ON A CUBAN ESTATE.

operate the rich copper deposits in the neighborhood of Santiago de Cuba, which they worked till the year 1868 with pronounced success. A railroad twelve miles long was built from the mines to the port by a separate company, and that also proved very remunerative, as dividends of over 25 per cent. were paid for many successive years. The question of again putting the railroad in operation has lately been agitated. With some repairs to the roadbed, it could be put in working condition at a moderate cost. This would not only incite the renewal of operations at the old copper mines, but also encourage the working of some of the manganese deposits that have lately been discovered in the vicinity.

The Cuban iron-ore deposits are found in the Sierra Maestra range of mountains, which skirts the southern coast of the province of Santiago de Cuba, and they form one of the most important groups of non-phosphoric Bessemer-iron mines in the world. Many cargoes of the ore have turned out between 58 and 64 per cent. of metallic iron, and as high as 69 per cent. of picked samples. This ore can be mined with great facility, since no shafting or tunnel is required, but only side-hill cuts. Though this mineral had long been known to exist in Cuba, it was not until 1880 that the people awoke to a full realization of the enormous wealth that is stored up in the mountains. During that year many applications were filed in the Government offices for titles of ownership. Shortly afterwards negotiations were closed with a syndicate of Pennsylvania capitalists for the sale of the Juraguá group of mines, and concessions were obtained from the Government to build a narrow-gage railroad from the mines to the port of Santiago de Cuba, this railroad to be exempt from taxation for ninety-nine years and all the material required for its construction and maintenance to be admitted free of duty. Seventeen miles were built through a very mountainous country, and the first carload of ore was shipped late in 1884. So great has been the demand for the ore that during 1891 about 330,000 tons were shipped, the handling of which required twenty locomotives and more than 2000 cars. It is estimated that over $3,000,000 have been spent in this enterprise, with gratifying financial results. The company control a regular line of iron steamers plying between their iron pier in the port of Santiago de Cuba and North American ports. Most of the ore is consumed by the Pennsylvania Steel Company and the Bethlehem Iron Company. In 1890 the Signa Iron Company, composed of Philadelphia capitalists, was organized, which purchased another

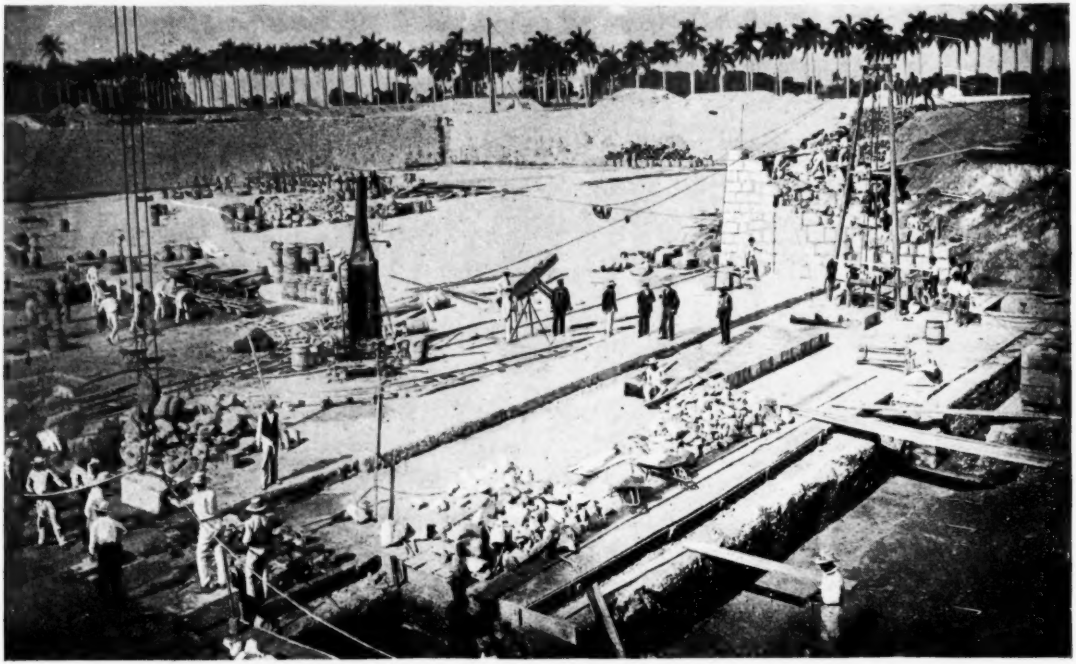
THE COUNTRY TRADER IN CUBA.

group of mines in the same mountain range, about thirty miles from Santiago de Cuba. They have built eight miles of a standard-gage railroad to the coast, and a pier supporting ore-pockets of 5000-ton capacity. The Spanish American Iron Company, with western capital and headquarters in New York, is another concern, which is now developing a third group of iron mines situated between Juraguá and Signa. The mines are four miles inland, and the railroad and ore-docks are now being constructed. There are many more groups of rich Bessemer-iron mines in the same range.

In the smaller ranges of mountains, parting from the Sierra Maestra, rich manganese deposits are found. It is only due to the very cheap way in which this ore can be mined in Cuba that it was possible to ship during the fiscal year of 1890–91 over 25,000 tons, as in most cases the ore had to be carried by mules for a distance of from two to fifteen miles. The most promising group of manganese mines, on account of the abundance of the mineral, its richness, and the low cost at which it could be mined, is probably that known as Ponupo, about twelve miles from the Cristo station of the Sabanilla and Maroto railroad, which goes to Santiago de Cuba. Not only would a branch road to Ponupo serve to transport the ore from those mines, but it could pick up considerable local traffic from sugar-estates and coffee-plantations in the neighborhood, and also from smaller groups of manganese mines. If we consider the probable effects of the locomotive traversing such fertile but yet uncultivated fields, the chances of success are greatly increased. Besides, the crying need of the province of Santiago de Cuba is a railroad from the city of that name to Guantánamo, a distance of about sixty miles. The Ponupo railroad would be a step in that direction, as with the lines already in operation it would cover nearly half the distance. Such a railroad would command not only a good deal of local traffic, but also a large share of the trade between the two places, which is now monopolized by a line of steamers charging exorbitant rates.

Among the engineering enterprises in Cuba may be mentioned the Vento waterworks, now nearing completion, which will supply the city of Havana with pure spring-water. These works were designed by the late distinguished Cuban engineer, Don Francisco Albear, about thirty years ago. Work was begun and continued for a period of fifteen years, at the end of which time the appropriations were exhausted, and very little more was done until the early part of 1890, when a $3,000,000 contract was awarded to Messrs.

OLD-TIME VOLANTA, THE CUBAN EASY-RIDING VEHICLE, IN A STREET IN HAVANA.



DOUBLE RESERVOIR AT THE HAVANA WATERWORKS, IN PROGRESS OF CONSTRUCTION—CAPACITY 16,000,000 GALLONS.

Runkle, Smith & Co., of New York, for the completion of the work. The water-supply is derived from a large number of streams which have been led into a collecting basin at Vento. To take the water from this basin the Almendares river has to be crossed, and this is done by means of an inverted syphon composed of two 40-inch pipes laid in a tunnel constructed under its bed. After crossing the river the two pipes merge into an egg-shaped masonry conduit having a maximum internal vertical diameter of 7 feet 10 inches and a maximum horizontal one of 6 feet 7 inches. This aqueduct is nearly seven miles long, and discharges into the reservoir, which will eventually be covered, at the rate of 62 cubic feet per second. This reservoir, having a total capacity of 16,000,000 gallons, is divided into two equal ones by a partition wall, making the dimensions of each 230 feet by 230 feet and 20 feet in depth. The distribution pipe can be fed from either or both reservoirs. Eighty miles of cast iron pipes varying from forty-two inches to four inches in diameter have been laid,and the work will probably be completed early in 1893, when the cost will have amounted to $6,100,000. Mr. E. Sherman Gould, Member of the American Society of Civil Engineers, is the consulting and executive engineer for the contractors. He has been assisted at Havana by a staff of four Cuban engineers, three of whom are graduates from technical schools in the United States. For many years Cubans desiring to enter the engineering profession were educated at Madrid and L'Ecole Central, Paris. In late years, however, the United States has become a more desirable place for students of engineering, and now a large majority of the Cuban engineers receive their training in the latter country.

Havana is a city of 250,000 inhabitants, combining the comforts of American cities with some of the peculiarities of European capitals. Being only three days from New York, it has become so well known to the North Americans that it is hardly necessary here to dwell on its busy streets, its notable buildings, handsome theaters, and picturesque surroundings. Similar reasons will prevent our entering upon a description of the other cities in the island. Electric lighting has been introduced in several of them, but still some of the cities and villages offer unusual inducements to capital for the introduction of this means of illumination.

As an evidence of the productive capacity of this island, it may be mentioned that Cuba not only became a self-supporting colony as early as 1827, but from that time contributed yearly to the Spanish treasury from her surplus a yearly tribute of from $1,-

000,000 to $6,000,000. Don José del Perojo, a Spanish representative at Madrid, in a speech before Congress a few years ago, estimated that what Cuba had remitted to Spain, in hard cash, amounted, up to that time, to $137,000,000. Those remittances ceased in 1868, with the outbreak of the insurrection that threatened for ten years to sever the colonial ties that bound her to Spain. During that sanguine period, to meet the large expenses of the Government, taxation rose as high as $80 per capita. In the last few years annual taxation, direct and indirect, not including municipal taxes, has amounted to $25,000,000, or $16 per capita. We know of no other civilized country so heavily taxed. The people of the United States pay only $6 per capita, and in Spain the annual drain upon the pockets of the tax-payers is only $10. In many countries the tax-payer sees his money devoted to public improvements, but half the revenues of Cuba are spent in supporting the navy and an army as large as that of the United States, and another large share helps to defray the debts of Spain contracted in wars in Africa and Santo Domingo. If, with all these disadvantages, Cuba remains a prosperous country, it must be because Nature in her prodigality has destined this to be the garden spot of the new world. Surely, in all the wealth of resources which has been here outlined is some inducement for a more widespread interest in Cuban trade than has yet been manifested by the enterprising business men of the United States, especially since the island has met her northern neighbors more than half-way in the concessions made under the recent Reciprocity arrangement.

ELECTRICITY.

Conducted by Franklin L. Pope.

THE first section of the overhead railway in Liverpool, which has been constructed upon the same general plan as the elevated railways of New York city, is nearly completed. It is about six miles long, double track, and has fourteen stations. It is to be operated by electricity, generated at a power house near the middle of the line. There are three dynamos, each driven independently by engines of 400 indicated horse-power. The electric conductors are steel bars, laid between the track-rails and supported upon porcelain insulators. Sliding contacts are to be used instead of trolley-wheels. Each train will consist of two cars mounted on trucks of the American type, each seating fifty-six passengers, and provided with a motor at one end. The cars are so coupled that there will be a motor at each end of the train, both of which may be controlled from either end at will by the driver. Each train, with its complement of passengers, weighs forty tons. The cars are lighted by electricity and are fitted with Westinghouse brakes, supplied from reservoirs of compressed air carried on the train. An automatic electric block-system of signaling is to be employed. It is intended to commence running with a five-minute service of trains, but the capacity of the plant is sufficient for a three-minute service if required. Half an hour will be required for the trip one way, including stops. The total cost of the road and equipment is said to foot up about $400,000 per mile. This is by far the most important example of electric-railway engineering which has yet been carried to completion, and the results of its operation will be awaited with no little interest. It will throw some light upon the question of the commercial practicability of introducing electric traction upon the elevated railways of New York, although it will be noted that the service here is at least three times as heavy as that of the Liverpool line.

A VERY ingeniously-constructed closed underground conduit for electric street-railways has recently been brought out in England, which would certainly seem to possess sufficient merit to justify a trial upon an extensive scale. The conduit has a comparatively broad slot, closed with a stout, continuous, but slightly flexible iron cover, which ordinarily lies flat, like a rail, within a trough, its top flush with the surface of the street. To enable the current collector upon the car to make contact with the electric conductors within the conduit, the elongated cover is raised from its seat as the car passes along it, by rollers carried upon goose-necks attached to the car. As soon as the car has passed, the cover drops back into its place, and hence at any time the conduit is only open beneath the car, being closed before and behind it by the cover rail. The wide slot made possible by this system enables the collector arms to be made of ample strength, while by removing the cover any part of the conduit and its enclosed conductors can be conveniently got at for repairs without taking up the pavement. In this country, where so many of the vehicles in ordinary use have very narrow tires, the abolition of the open slot is an advantage which can scarcely be overrated. If the new idea proves to be feasible in practice, it certainly would seem as if substantial progress had been made in the direction of a practical conduit system, especially in view of the fact that insulators are now made with self-renewing surfaces of non-conducting oil, which will maintain their insulating properties in spite of any reasonable amount of dirt.

IN discussing the question of the possibility of attaining railway speeds of 100

miles and more per hour, by the employment of electric motors, it appears to have been tacitly assumed that one of the principal difficulties would be found in the imperfections of the track, if constructed according to existing practice. An engineer writes to the *Railroad Gazette*, pointing out the fact that, in that journal's report of railway accidents for August, 31 per cent. were chargeable to negligence in operating, 15 per cent. to defects in equipment, and only 5 per cent. to defects of track. He thinks that these figures do not indicate that the track is so much behind, and suggests that "the motive power department will have to get some other excuse." The more this aspect of the question is considered, the more one becomes impressed with its importance. At such speeds as are talked of it will no longer answer to depend, as is now done, solely upon the vigilance and promptness of the engine-driver, to avert accidents. If a small wire were to be stretched the length of the track, five or six feet from the ground, and charged by a constant current, it might easily be so arranged that the severing of this wire at any point would cut off the power and apply the brakes to every moving train within a prescribed distance. Thus every inch of the track could be kept under constant inspection by a corps of watchmen, and a large proportion of accidents due to collisions with obstructions of various kinds might be averted. The philosophy of the occurrences which are too often miscalled "accidents" needs to be more carefully studied than it has heretofore been if the present speed of traveling is to undergo any radical increase.

THE electric current for operating street-railway motors is supplied at an approximately uniform pressure of 500 volts. Hence the speed of the motor, under various loads and conditions of service, can only be varied by varying either the volume of current which is permitted to pass through it, or the effect of a given current upon the motor. Two methods of speed-control are in practical use, one of which depends wholly upon an adjustable artificial resistance external to the motor, and the other employs, in addition to this, a variable coupling up of the windings of the field magnet of the motor. Much difference of opinion has existed among practical men as to which method is on the whole the most economical of electric energy. This question has been examined by Mr. Thorburn Reid, who, in a communication to the *Electrical Engineer*, shows that there is in fact a considerable difference, and that this difference is in favor of the "commutated field." We think that this is the conclusion which most persons would have reached by *a priori* reasoning, and that the real question at issue is whether the simplicity of construction attainable by the use of the external resistance alone is of sufficient practical advantage to compensate for its greater wastefulness of energy. This can only be conclusively answered by the results of actual experience.

AT the recent annual meeting of the Street-Railway Association of the State of New York, one of the most significant features of the proceedings was the entire absence of any discussion as to the operation of these lines by horse-power. All the reports of the committees, as well as the discussions thereupon, had reference solely to electric railway construction and methods. Not one word appears to have been said on the formerly all-absorbing topics of feeding, shoeing, and stabling. Nevertheless we observe that the sapient editors of most of the leading journals of New York continue to assert that the "deadly" trolley has proved a failure and a curse in every locality in which it has been introduced, and that the only safe and successful electric system is that which makes use of storage batteries.

REFERENCE was made in these notes, in the May number, to the destructive effect upon the rails of the track resulting from some of the plans of mounting street-car motors now greatly in vogue. The observations then made have since received forcible confirmation in the statements of some of the street railway managers at the recent convention at Saratoga. One member said

emphatically that "there was nothing known in traction that compared with the pound on the track by an electric motor." It appears that even when 70-pound rails are used, which are heavier than any used in the steam railway service except upon the most important trunk lines, it is almost impossible to maintain the joints in good condition. One difficulty of course is that on steam-roads the joints are easily got at by the trackmen, and can be kept screwed up, while on a street railway they are usually below the pavement and cannot be reached without considerable trouble and expense. This problem of injury to the track is a very serious one, and unquestionably calls for much more attention than it has yet received at the hands of the majority of manufacturers of street railway equipment.

WE fear that some of the members of the American Society of Civil Engineers may be led to entertain very erroneous impressions of the efficiency of the modern electric railway, if they take it for granted that a paper recently presented to the Society, embodying the results of a series of test measurements made in 1889, furnishes any criterion of the modern state of the art. In electric-railway development, the period from 1889 to 1892 can only be compared to the proverbial inch on a man's nose, in respect to the remarkable changes which it has wrought. While there is no reason to doubt the fairness and accuracy of the tests reported in the paper, it would seem as if the fact that they were made upon a crudely-constructed plant, of a type now wholly obsolete, should have prevented their presentation before a learned society, after the lapse of so long a period, without a word of explanation or apology.

THE central electric station at Springfield, Ill., supplies current not only for lighting the city, but for operating the street-railway system. With a view to economy of expenses, the management some months ago determined to annex to the plant a system for utilizing the exhaust steam by furnishing heat to a number of business blocks in the vicinity. The original plant laid down provides for heating about 2,000,000 cubic feet of air space. The charge per annum is 20 cents per square foot for direct radiation and 25 cents for indirect radiation. This price is found to yield a generous profit to the station, and is very advantageous to the consumer as well. The profit, at present prices, is estimated to be at least double that realized from the sale of light and power. It is now announced that the results have been so satisfactory that it has been determined to extend the pipes to a distance of a half-mile from the station. It seems not improbable that the time is coming when the average householder will receive his heat, as he does his electric light, power, water, and gas, and will no longer be compelled to struggle in frigid desperation with the malignant hot-air furnace.

A RURAL farming district in Michigan has provided itself with a telegraph line eight miles in length, connecting a large number of scattered farms with the village store, the proprietor of which officiates as telegraph operator, express-agent, postmaster, and so on. The total cash expenditure for the outfit is said to have been only some $200, while the expense of maintenance, which is but a trifling sum, is assessed equally upon the owners. The small cost and enormous convenience of such a system as this in country districts ought to lead to a more general adoption of the plan. Especially after the expiration of the telephone patents in 1894, such a system of intercommunication by wire would be possible in every township throughout the country. The individual expense would be almost insignificant, and in the item of useless travel alone would save many times its cost every year.

ONE of the most remarkable examples of long-distance electrical transmission yet put in operation is that which has recently been completed in Rome. The generating station is at Tivoli, eighteen miles distant. There are six turbines of 330 horse-power, and three of 50 horse-power, each. Three alternating dynamos each furnish a current of 42 amperes at a potential of 5100 volts.

These are connected in parallel to the line, which consists of four copper cables carried across country overhead upon oil insulators fixed upon iron poles. The current reaches the sub-station in Rome at a potential of 4000 volts, where it is reduced to 2000 volts by means of 32 transformers of 25 kilowatts each, at which potential it is distributed throughout the city. The total energy transmitted amounts to about 1200 horse-power.

A NEAT little improvement has recently been introduced into the domestic electric annunciator. Each new call is made to restore to its place the device which indicated the previous call, so that it is no longer necessary to depend upon a servant or attendant to do it. A little thing, one might say, yet the aggregate of annoyances to the housekeeper arising from the trifling shortcomings of modern conveniences, as we are but too well aware, tends materially to diminish the sum total of human comfort.

THE most important advance ever made in the construction of the dynamo-electric machine, with the possible exception of the discovery of the principle of self-exitation, was that of the endless or "ring" winding of the armature, due to the genius of Antonio Pacinotti, of Pisa, Italy. From a sketch of the life and work of Pacinotti, published in the *Electrical Engineer*, it appears that he was a mere boy at the time when he made his discovery or invention, being then less than twenty years of age. The extracts from his working notes, given in this article, accompanied with fac-similes of the accompanying sketches, are of rare interest.

THE most advantageous frequency for use in systems of electrical distribution for alternating currents is a question which has been much discussed of late in the columns of the electrical journals. The question is not an easy one, because the best frequency depends largely upon the purpose to which the current is to be applied. For general electric lighting, 60 or 70 alternations per second are about the minimum limit that will insure perfect steadiness in the illumination. In house-to-house distribution with many small transformers—the usual American practice—a frequency of 120 to 200 is found to be more economical, for the reason that it makes possible the use of small and cheap transformers. With high frequency the resistance of the mains is greater, so that more copper must be used, or else a greater margin of loss allowed for in the line. For power-distribution, or for lighting from sub-stations where very large transformers may be employed, it would seem advisable to make the frequency as low as admissible. Of course, in every case of transmission of power the problem becomes in reality a special one, and must be solved by the engineer in accordance with the special conditions which he is compelled to meet.

IN an address before the Society of Chemical Industry, Professor J. Emerson Reynolds pointed out that the true policy of the gas-manager should hereafter be to study how to produce the highest calorific effect, instead of wasting his energies in vainly endeavoring to compete with electricity by seeking to secure a higher illuminating power. "As an illuminant," says Professor Reynolds, "gas is being so certainly displaced by the electric light that the objections hitherto urged against the supply of gas of high calorific value, but of low illuminating power, have almost ceased to have any practical force." He thinks that gas companies may, in the future, not merely maintain but increase their profits by becoming purveyors of heat-energy for domestic use, and for many manufacturing purposes as well, not excepting the production of the electric light itself. Nothing is more certain than that in the future we must look in the direction indicated by Professor Reynolds for true economy in the use of our remaining store of coal.

IT is a matter of some curiosity to note the different attitudes assumed towards London fogs by gas and electric-light managers, respectively. To the gas-man-

ager, the sudden fog has no terrors; the only thing he has to fear is a spell of darkness so protracted as to exhaust his reserves of gas. The electric-manager, on the other hand, having practically no reserve to draw on, other than idle machinery, of which he usually has enough and to spare, finds much satisfaction in the occurrence of a prolonged period of gloom. So long as the coal-pile holds out he is happy.

THE original plans for the electric lighting at the World's Fair contemplated the installation of 100,000 incandescent lamps, which it was thought would be ample for the interior lighting. It has already been found necessary twice to increase this allotment, and, according to latest advices, the number required will fall little if any short of 300,000. One-third of this number probably will be required in the Electricity building alone.

ONE of the most noticeable features of the recent reunion of the veterans of the Grand Army at Washington was the extent and beauty of the electric illuminations, which far surpassed anything of the kind hitherto attempted. A complete three-wire system was installed, drawing current from every available dynamo, public or private, in the city. One hundred arc-lamps and 25,000 incandescent lamps were included in the display. One of the most effective set pieces was a Grand Army badge at the head of the avenue, eighteen feet in height, composed entirely of incandescent lamps. The eagle was outlined in white lamps, the cannon in blue, the national emblem in the regulation colors, and the pendant star in amber. Ten revolving stars of different designs were set up in the grounds of the White House, which were kept constantly changing in pattern and color. A number of monster search-lights were also used with brilliant effect. The whole work was designed and executed in the brief space of thirty days.

IN the town of Carlow, Ireland, the recent establishment of an electric-lighting plant made serious inroads on the business of the local gas company, which at the end of a year found that its competitor had secured about 25 per cent. of its revenue. The foolish step was then taken of issuing a notice to consumers that any one using electricity would at once be cut off from the gas-mains. The London owners of the electric plant at once sent to the seat of war a large force of men, well supplied with material, with the result that the utter destruction of the gas-lighting business in that locality is apparently but a question of a few weeks at most.

THE British Admiralty tests of engines and dynamos for naval electric plants are quite severe in their requirements. The dynamos are required to be of the direct-current compound-wound type, giving usually 400 amperes at the standard pressure of 80 volts. The machinery is first tested on a continuous run of six hours at full load. The steam-pressure, amperage, and voltage are taken every half hour, as well as the temperatures of the testing-room, field-magnets, and armature. The maximum temperature of the armature at the end of the test must not exceed that of the room by more than 70° F. The engines and dynamos are also expected to stand without injury the sudden removal of the full load by breaking the circuit, and this without an increase of more than 25 per cent. either in speed or voltage. It is stated that less than four years ago a dynamo meeting the Admiralty requirements weighed nearly eight tons, but, by reason of the improvements since made, the conditions can now be fulfilled with a weight of five tons.

SINCE the German Post-Office authorities have gone so far as to absolutely prohibit the erection of electric-power circuits in the vicinity of telephone lines, attempts are being made by the inventors of that country to find a remedy for the objectionable disturbances. One plan which has been proposed is to place an induction coil in the middle of any grounded telephone line subject to inductive disturbances, it being expected that in this way the in-

duced currents will neutralize themselves. Another suggestion is to employ a double-wound coil having one wire in the disturbing and the other in the disturbed circuit, and to proportion and wind these so that they will exactly neutralize the induction of the straight portion of the circuit. It does not appear whether or not these expedients have yet proved of any value in practice. It certainly could not cost much to make the experiment.

MR. RANKIN KENNEDY, of Glasgow, the originator of the modern system of distribution of alternating currents in parallel, strongly favors the employment of multiphase currents for long distance transmission. In a communication to the *Electrical Review* (London), he points out that such currents may be generated without difficulty at potentials as high as 10,000 volts, owing to the simplicity of the machinery, and the entire absence of commutators and brushes; and that such currents may be conveniently and economically reduced to any required pressure, and converted into continuous currents when required. He contends that there is only one possible way in which a steady all-day load can be approached, which is by making use of storage. As the actual distribution under the proposed system would be at low pressures with continuous currents, storage might be employed to any extent, and the load on the generators thus rendered almost constant.

IN one of the new power-stations about to be built in St. Louis, it is announced, only three generators of 800 horse-power each will be employed to operate sixty-five large cars, each equipped with 50 horse-power of motors. The generators will be of the multipolar type coupled direct to the engine shaft.

ONE of the railroad lines near Chicago is being equipped with an electric block-system by which not only is a signal exhibited, but the train is automatically stopped in case the track is obstructed. When the semaphore signal stands at "danger," an electric current is turned into a rail, laid like a guard-rail parallel to one of the track-rails and opposite the signal-post. When the locomotive passes this rail, an electrical connection is established between it and an electro-magnet in the cab, which instantly closes the throttle and applies the air-brake to the train. The apparatus is stated to have been tested under an actual use of three years, with most satisfactory results.

AFTER more than six years of stubbornly-contested litigation, the patent of Edison covering the essential features of the modern incandescent electric lamp has been sustained by the United States Court of Appeals, and his legal right to the invention finally established. In view of the vast number of lamps which have been made and are now in use, in disregard of the Edison patent, much interest is naturally felt in electrical circles as to the policy which is likely to be adopted by the present owners of the patent towards these competitive interests. If all manufacturers of incandescent lamps were to be summarily enjoined, it seems certain that the existing facilities of the General Electric Company would be wholly insufficient to supply the current demand, and hence it appears not improbable that the infringing manufacturers, or at least the more important of them, may be permitted to continue the manufacture upon payment of a royalty. It has been announced, apparently by authority, that no steps will be taken which will have the effect of enhancing the cost of lamps to the consumer. The Westinghouse company have announced that they will shortly put on the market an improved lamp of low cost and high efficiency, of a construction not covered by the Edison patent. It is said that the incandescent lighting of the World's Fair is to be done with these lamps, of which a large number have already been manufactured. The owners of the Edison patent, on the other hand, do not hesitate to express the conviction, in the most unqualified terms, that no such lamp is possible to be made. The outcome of this state of affairs will be awaited with much interest.

MECHANICS

Conducted by Frederic R. Hutton.

THE question of the expediency of one large engine with shafting or rope transmissions to segregated shops is one which presents itself to every designer of an extensive plant. The reason for dividing the shop into different buildings is mainly the outcome of considerations with respect to fire, although matters of supervision are not without their bearing. It is unquestionably an advantage to have one central boiler-plant on account of insurance, economy of handling coal, and economy of attendance. One chimney also will answer for the entire plant, and the boiler units can be distributed so as to meet the call for steam as it may vary in the different departments. Concerning this subject there is practically no room for discussion until the distance which the steam must be carried becomes excessive. Just where the adjective "excessive" begins to apply is one of those difficult questions which the engineer must solve usually on the basis of judgment rather than according to any settled principles laid down by theory. There is no difficulty in carrying steam six hundred feet; it begins to be a serious question whether it is advantageous to carry it more than fourteen hundred feet,—or a quarter of a mile,—or where the magnitude of the demand for steam would necessitate a pipe over eight inches in diameter. The cost of the pipe and the interest on the outlay would figure up very largely in comparison with the cost of a separate boiler-room close to the place where the steam was wanted. Within these wide limits, however, the engineer must decide each question as it arises.

Again, the advantages of small engines, where wanted, as compared with continuously running shafting from the central motor by which the power is conveyed to the distant tools, will be determined very largely by local considerations. Speaking generally, when the friction of shafting and the length of transmissions begin to exceed in cost the condensation in the steam-pipes carefully protected by non-conducting material, the question of subdividing the power comes to the front. There are, moreover, advantages which follow from the independence of the different parts of the shop when any incident compels the shutting down of the transmitting machinery. By the subdivided system, only that part need be put in idleness in which the breakdown has occurred. Besides, in boring cylinders and other work of that class, where it is desirable that there be no break in the continuity of the process, the entire plant does not have to be run for the sake of the boring-mill. The same is true in overtime work upon rushed jobs affecting but one subdivision of the entire plant. There is also the advantage, which presents itself in many places, that one part of the shop, turned for business reasons upon a special class of work, could be run more slowly or more rapidly than the average speed for which the transmitting machinery is adjusted. Subdivided power makes that saving possible. In these days of automatic engines with sight-feed lubricating devices, the attention needed by groups of small engines becomes so little that it need scarcely be considered as adding an element to their cost. The force required to look after the one large central engine can cope with the number of subdivided ones.

THE molecular effect of the operations of cutting tools upon a large mass of metal is perhaps not generally recognized. The principles of the conservation of force demand that the amount of work passing through the belt of a boring-mill which is at work upon a cylinder should be equal to the amount of energy represented by the severing of the chip, and the heat which is

the result of friction and the reaction of internal forces. With a heavy chip this heat-energy becomes considerable, and may raise the temperature of the iron sufficiently to produce a visible expansion. When we consider the circumference of the cylinder being bored, if the work of boring be stopped for an hour at noon, or over night, the cylinder will contract so much in cooling that the tool, when it resumes work, will take a deeper cut than before the stoppage. The consequence of course will be a jog in the cylinder, which will constitute a defect.

SOME members of the American Society of Mechanical Engineers, at a recent conference, were discussing the subject of the actual cost of producing the steam-power used in manufacturing. It will be recalled that figures covering a wide range have been given for this item, which difference can be explained partly by the difference in location, as the accessibility of the coal-supply bears upon the subject, and partly by reason of the difference in the size of the plant. It is well-known that a large engine working to its full capacity is more economical than a small one, and this will be a standing argument bearing upon the advisability of subdividing the power in a large area, so as to drive different sections of it by small engines receiving steam from the common center. A most carefully managed plant, eighteen miles out of Pittsburgh, where coal can be delivered for 80 to 90 cents per ton, reports an outlay of $17 per indicated steam horse-power per annum, with all costs of fuel, labor, and repairs of boilers included. They use about 600 horse-power of sectional boilers, the steam for which is used in Westinghouse compound-engines. Their coal is of a quality which requires from 2¼ to 2½ pounds per horse-power, and the plant runs continuously twenty-four hours per day throughout the week.

IT is one of the favorite complaints of the modern pessimist, in discussing naval and marine matters, that the sailor is being replaced by the mechanic, and the "heart of oak," in its figurative sense, is either absent or is hidden behind a greasy jumper. There has lately appeared in London a translation of an extremely interesting paper showing the extent to which the demands for heavy work on board a war-ship have compelled the substitution of machine power for the old hand purchases of the early navies. The author is Nabor Soliani, one of the best known constructors of the Italian admiralty, and he calls attention to the number and power of the auxiliary machinery in a modern iron-clad, illustrating his thesis from the equipment of the *Re Umberto*, of the Italian navy.

This auxiliary machinery can be grouped into water-pumps, of which there are eight series; steering-gear, capstan machinery, dynamos, compressed-air pumps, forced-draft engines for the boiler-room and ventilating machinery, turning and starting gears, ash-hoists, and workshop engine. The total aggregate, as computed by Mr. Soliani, reaches the surprising sum of 2480 horse-power; and while of course these are not likely to be in action all at once, still the total remains considerable. Mr. Soliani discusses the five usual methods by which power can be gotten from central steam supplies to the points where it is to be used; which are, (1) the rigid or flexible mechanical transmissions involving shafting ropes or belts; (2) by steam, in which case each apparatus must have its own engine; (3) by water pressure, involving hydraulic engines at each point; (4) by compressed air, involving air engines at each point; and (5) by electricity, involving motors at the operating points. The rest of Mr. Soliani's paper is largely taken up with a very interesting discussion of the relative advantages and disadvantages of these systems. It may not be uninteresting to consider some of the questions which are suggested by this discussion.

THE transmission by positive mechanical means is practically of no moment in a war-ship, for the reason that it compels the use of considerable room which can ill be spared. Bulkheads which ought to be water-tight must be pierced; alignment is difficult in a hull which has any flexibility under the exacting strains of sea-service, and belts are never at their best when used

in places where damp air can have access. It will be recalled how serious was the embarrassment on board the *Monitor*, of Ericsson's design, when, in a sea-way, the belt driving the ventilating engine got so wet that it began to slip. The entire crew were in danger of suffocation, as there was no natural draft from the low smoke-stack. Rubber belts or waterproofed rope seem to be the only satisfactory solution for this particular case.

The plan of subdividing steam-engines, as the second method, offers many of the advantages discussed above. Certain special conditions aboard ship have an influence in deciding the question. The first is the liability to condensation which is present in the damp air of a sea-going vessel, making an elaborate drainage system a necessity for the pumps and machinery if the difficulties are to be avoided from water in the pumps and cylinder. It is well known how harmful water can become in an engine intended to work with steam, either stopping its working completely, or endangering the integrity of the castings against which it can come with dynamic effect. If the steam-pipe to any engine should pass through a compartment which had been flooded, the condensation might interrupt the action of many machines. Moreover, if the steam-pipe can be injured by shot or other disaster, great harm may be done by the escape and expansion of the steam leaking before it can be cut out.

In the third place, the steam circuit must be complete, carrying the steam from the boilers to the segregated engines and back again to the condensers, in order that all water evaporated may be returned to the boilers, avoiding the necessity of drawing feed-water from outside supplies.

Again, the lubricating material which must be used at the subdivided engines must go back to the main boilers with the condensed water, impairing their good action and their durability. There is also the drawback for vessels in warm climates that the hot steam must necessarily heat those parts of the vessel through which the pipes are carried.

These adverse considerations, however, do not hold for the special machinery under the immediate control and contributing to the main engine as auxiliary to it. Here the use of steam is unquestionably the most convenient of the methods to be employed.

A NOTABLE event in industrial circles took place during the last week in September at Bethlehem, Pa. The mechanical engineer who has been for many years at the head of the engineering department of the Bethlehem Iron Co. was entertained at dinner by upwards of two hundred gentlemen,—his professional colleagues, or representatives of important corporations in close relation to the iron company. It will be recalled that this corporation is engaged upon ordnance material for the Government, particularly upon armor-plate, and that it has put up from the designs of its chief engineer some of the most massive machinery of this country, or of the world, intended for this specialty. Apart from the social and personal pleasure attending this event, there was in many minds an especial interest attaching to the underlying significance of the occasion. There was of course much in the atmosphere of affection which the man's friends feel for his great heart; there was much in the respect which every one feels for the ability and courage which has characterized the monuments he has erected for himself; but beyond all that was the fact of the public recognition that there was more in mechanical engineering as exemplified by one of its greatest living representatives than can be expected from the handicraftsman, the operative, or the draftsman. The social existence of a community cannot be carried on without the physician and the clergyman ministering to the personal needs of the individual members of the community; as the units of the community aggregate into corporations, the services of the lawyer cannot be dispensed with; but it is the creative mind of the great engineer, and in a manufacturing community, the mind of the mechanical engineer, whose labor and efforts are fundamental to the coming together of the community for which the other professions must serve. The public recognition of this fact and the bearing which John Fritz's life and work has had in

the development of the town of his choice were factors in the celebration in question; and, so far as is known to the writer, this is the first time that the representatives of capital and corporations have given to the engineer a recognition of this sort in America. In England this type of recognition has come to many eminent men in the form of a baronetcy, and as a result of this policy the standing of engineering as a profession is better in the Old World than in the New. The occasion was thus made one of special note as the symptom of the favorable sentiment which can only be expected to grow with future knowledge of what the really creative function is when exercised by the true engineer.

AN interesting example of the way in which the several specialties of engineering must interlock with each other in these present days of high standard in important undertakings is shown in the discussion connected with the pivot and turning mechanism of a large swing-bridge recently completed at Dieppe, in France. While of course fixed span-bridges of great length are becoming more usual, where the span exceeds a hundred feet for the swing channel it becomes a structure of notable weight, and mechanical means must be resorted to for its turning and for adjustable supports of the bridge at the center and abutments. There was no doubt at Dieppe that hydraulic power was the most practicable system, but the question as to which of the three systems to adopt for applying the power to the operation of the bridge was purely a mechanical one, and its discussion becomes of interest. By reason of the form of the water-way, the pivot was not in the center of the span, though this does not affect the discussion of the three methods. The more usual custom in this country is to have the superstructure forming the bridge support carried upon a central pivot and turn-table, the rollers of which carry the weight of the bridge. The supports at the abutments are movable and are released either by the withdrawing of wedges, or cams, or the release of hydraulic presses under the ends of the girders.

The hydraulic system is open to the criticism that where the pumping machinery is at the center of the bridge, and the pipes controlled from thence, the fluid has to be led down to the bottom across the channel, and up again, with the inconvenience from frost and corrosion and leakage in inaccessible places. This system in the French discussion is called the second system, which makes its first system one with which we are much less familiar in this country: which is the lifting of the central pivot by hydraulic power until the deflection of the two semi-girders is taken up in the slack of the bracing and the fixed supports on the abutments are freed. The bridge then turns upon the hydraulic pivot with the diminished friction which the hydraulic support gives, and then the turning effort is exerted.

There is a simplicity about this first system for short spans, but for large ones it is not so applicable. In the first place the great weight of the structure, causing a good deal of deflection in a long span, makes the lift considerable in amount. The pivot thus comes to be of large dimensions, and side pressure from wind brings a very material side strain upon the pivot and its attachments to the bridge, which they must be made strong enough to withstand. If, moreover, during the time that the bridge is open, there should be any failure of the packing or of the piping connections, or hydraulic machinery, the descent of the bridge with suddenness from such failure might produce great damage. The objection is made that in the second system the turntable constitutes a complicated mechanism which is costly to maintain, and which must be kept in good condition so as to permit of careful working. The third system, which is called the balance system, so adjusts the distribution of weight upon the semi-girders that one end shall be slightly heavier than the other. In the carrying out of this principle at Dieppe, the short end was made the heavier. The central pivot is hydraulic, and under the heavy end are two similar hydraulic presses, which are called balance presses. The water pressure, when let on the central pivot, tends to lift the bridge

at the middle, but the area of the plunger at that point is not sufficient to lift the bridge off its end supports. When the pressure is let upon the balance presses, the bridge is then lifted by the combined area exposed to the water pressure, and the bridge rises around the further end as an abutment. The supporting and locking gear can then be withdrawn at the short end. When the pressure is let off from the balance presses, the heavy end sinks, carrying down the central pivot by the excessive weight until the pivot bottoms on its cylinder, when the light end rises off its abutments and is thus freed. The heavy end settles upon a sector of rollers, by which it is carried and supported while open, but of course the pressure upon these rollers is the difference between the weight of the light and heavy ends, and is not so great in amount if the spans are not very unequal. The turning mechanism for such a bridge operated by hydraulic power is a hydraulic cylinder operating a chain or rope which rotates the crown of the turntable.

ENGINEERS have had their attention drawn recently to the question as to whether our present industrial system may not be in danger of running itself out, as respects the training of skillful molders for the foundry. The technical schools are turning out batches of young graduates who enter the machine- and pattern-shops to learn the details of shop-practise as it can be learned there only, but it is in rare cases that any one is found who becomes a molder, with this same object in view. The restrictive policy pursued by so many trade organizations in the matter of discouraging the taking of young apprentices extends also to this shop department, and the consequence is that, as the older practitioners die or are found incapable of meeting the more exacting demands of the present practise, no one is found capable of succeeding them from the ranks of the young men. While it would be invidious to speak of one handicraft as making greater exactions than another, yet, so far as merely mechanical skill is concerned, the molder stands well up in the line with the blacksmith and the wood-carver in the demands imposed by a knowledge and knack to be acquired by experience only and not out of books. The foundry, moreover, concerning itself with the very fundamental form and molecular structure of these masses which are to be treated and assembled in the machine-shop, certainly should yield to no other department in the importance of having its work rightly done. The failure of a casting is often the beginning of as serious a disaster as the failure of a tie-rod or the giving way of a riveted seam.

There seems no logical reason why the foundry should be undervalued. But it is. It is a dingy place, with a floor not especially agreeable, with windows rarely clean, and ventilation often defective. There are notable exceptions to this, of course, but it still remains true of the rank and file. The office management does not seem to take the same interest in the foundry as in the other departments, so far, at any rate, as interest is expressed in money expended to improve the standard which prevails in this department; and of course this state of affairs reacts upon the young men who visit the engineering establishments, as the technical-school graduates do. And this may be one reason which influences them. It is also partly to be explained by the fact that the old molder has often been unwilling, or if not unwilling, unable to give to the technical graduate any instruction which would be helpful to him. So much of the art of molding comes from the impressions conveyed by the reaction of his mold to the molder's practised hand that only one who is skilled in imparting nice shades of meaning would be able to tell the neophyte what he ought to know. So many of the professors, also, in the technical schools, are men who have had no foundry experience that they are for that reason less likely to appreciate its importance and urge it upon their students.

The absence from the foundry of young men technically educated has also been one reason why improved machinery has been so slow in getting into that depart-

ment. The idea of molding by machinery was introduced into practise many years ago in England, but in America it has penetrated very slowly into practise even where the necessity for making a very large number of duplicate pieces renders machine molding and the plant for it a most judicious investment.

IN the casting of car-wheels which are to have a tread made especially hard by fast cooling, the difficulty is met that, when the melted iron is poured into the mold, so that the exterior circumference comes in contact with the cold iron of the chill, it instantly solidifies and begins the contraction due to the cooling. On the other hand, the iron of the chill, becoming warmed by the heat of the metal within it, begins to expand, leaving the solidified surface of the tread, and permitting the action of the heat of the body of the wheel to undermine the chill. In the English classification of pig-irons they make a distinction between the two grades of white iron; one will become gray by slow cooling, while the other will remain white, no matter how treated. The two ways of getting around this difficulty are to make the chill massive but solid, or to make it hollow and conduct off the heat imparted to the chill from the iron within it, using either water or air. A recent improvement is to secure even a greater efficiency of the air cooling the chill by introducing into the chill compressed air, which should be allowed to expand and thus lower the temperature. The difficulties connected with water are the danger from unequal cooling; from accident, if the water should get into the mold from any crack in the chill; and the inconvenience of handling the water. On the other hand, the high specific heat of water makes it the most efficient absorbent of heat which can be used for cooling.

IT is obvious that for use in launches the gas-engine must appear in the form using oil and vaporizing it as required. The oil- or naphtha-engine has the advantage over steam of avoiding the concentrated weight of the boiler close to the engine, so that the boat can be made of lighter draft because of the distribution of the weight, as the oil-tanks can be put forward or wherever convenient. They also have the advantage of being made ready for use without the delay incident to getting up steam. The disadvantage under which they labor is that the power usually ample for smooth water purposes may not be capable of coping with a head sea and wind. In the Priestman launch engine using oil two nine-inch cylinders with a stroke of nine inches and a speed of 240 revolutions per minute give ten nominal horse-power. In this engine oil is forced through a spraying device into a chamber which is maintained at a high temperature by means of the hot exhaust products as they leave the cylinder. In this chamber the oil is vaporized, mixed with air, and drawn into the working cylinder at the outstroke of the piston; on the return the mixture is compressed to about 25 pounds to the square inch, and is ignited behind the piston by an electric spark. The oil used is a heavy petroleum with a high flashing temperature, and is forced into the heating chamber by a small air-pump. Reversing and stopping have to be done by transmissive mechanism between the engine and the propeller, as the engine-shaft turns always in one direction. The speed of the engine is regulated by a direct acting governor which cuts off part of the charge as required.

ARCHITECTURE.

Conducted by Barr Ferree.

FOR the first time the American people have celebrated a great public festival which was not directly concerned with national history. The Columbian celebrations of the past month, both in New York and in Chicago, were more impressive in their suggestiveness than in their reality; there was a vast deal of bunting and fireworks and popular fuss, without that thoughtful consideration with which the four hundredth anniversary of the discovery of America should have been attended. Yet, as a matter of fact, while the work of Columbus was one of the most sublime undertaken by mankind; while it stands alone among the records of human achievements; while he himself is worthy of all honor at the hands of the American people,—the discovery of America was an event spread over more than two centuries, and, so far as full knowledge of the present continent is concerned, has not yet been completed. Columbus did not know he had discovered a new world, and it was many years before this fact was finally impressed upon the minds of the adventurers engaged in opening the newly-found lands. This is scarcely the place to comment on this great beginning of American history, but in the midst of the turmoil with which the event has been commemorated it is well to pause for a moment and consider briefly the additions made to science, art, and industry by the American people. The contributions to knowledge made by America will be illustrated at Chicago next year more completely than ever before. Yet without pluming ourselves on our achievements, it is eminently fit to soberly consider what we have done and the steps by which we have accomplished it. In the matter of architecture America shows typical conditions of its own, with typical results and typical devices, called forth by American conditions, and necessitated by American methods. The New Zealander who, in time, will stand rapt in thought on the ruins of London bridge can experience no stranger sensations than the thoughtful American who makes a mental comparison between the American architecture of to-day and that found by Columbus in the West Indies four hundred years ago. The traveler who will go to the top of the Masonic Temple of Chicago and look down on the eighteen or more floors below him, through a court so deep that the brilliant white marble which lines it seems brown and almost black towards the bottom, will do well to compare it with the performances of the native American architects who were content with a hut of leaves, a tent of skins, a pueblo of mud, or perhaps of stone. Wonderful as were the achievements of the primitive architects of Central America, Mexico, and Peru, they offer little of interest compared with the gigantic undertakings which every American architect feels himself competent to undertake and does undertake, as a matter of business, with no more compunction or thought of accomplishing great things than in the eating of his breakfast rolls or the reading of his morning newspaper.

THE opening of the Schiller Theater in Chicago last month was an event of more than local importance, and of an importance quite as architectural as theatrical. In idea the theater is an office building. Such the structure really is, and such it appears to be, the exquisite balcony stretching along the lower part of the façade, and the finely-modeled cornice and belvidere of the tower, alone suggesting the festive nature of the edifice. And in this respect it stands unique among the business buildings of America. It is a thoroughly American attempt to provide an elegant and costly pleasure-palace at a miminum cost to the investors, which is

accomplished by building the theater as part of a modern office building. But the fact that it was a theater—that its purpose was not altogether strictly utilitarian, in the hardest sense of the word—necessitated some external expression, which the architects, Messrs. Adler & Sullivan, have very well given by means of their balcony and the finish to the top of the building. The ornamentation of the whole structure is concentrated upon these parts, where it is extremely rich and exquisitely wrought. Internally the theater exhibits some novel features of construction, some of which have been carried out by the same architects before, but which here receive a fuller and more complete illustration than in any previous effort. The balconies are supported without columns, thus permitting an absolutely unobstructed view from every part of the house. The proscenium arches are arranged on the speaking-trumpet plan, so successfully carried out in the Auditorium. Their rich decoration in relief and color, and with electric lights, forms an exceedingly effective feature, and, as Mr. Sullivan has managed it, an exceedingly artistic one, which is the more interesting from the strictly scientific acoustic ideas involved in the construction. Another important feature has been the suppression of the proscenium boxes, those last relics of the antique stage, if such may be the proper term, whose utility has long since expired, and whose continued reproduction in modern theaters have so long indicated the lack of originality of their designers. In the Schiller the space usually occupied by these useless appendages have been made an architectural feature, a bold arch enclosed in a rectangular frame, the whole treated in relief, and giving an architectural support to the proscenium arches where it is not only needed, but entirely in keeping with the unity of the whole. The building is one that will well repay ample study and may well serve as a model for future work in this important field.

WHAT in the world induced the editor of *Scribner's Magazine* to ask the editor of *Puck* to describe the "making" of the World's Fair at Chicago? To write on architecture, as on almost any subject under the sun, requires more or less knowledge of the matter at hand. There is nothing in the career of the editor of one of the leading comic papers, whose weekly distortion of men and things excites the risibles of the multitude, to qualify him as an architectural critic. It is hard, indeed, to say of one who is so exquisite a writer in his own fields that he does not know what he is talking about when he takes up the subject of architecture at the World's Fair, but what other opinion can any reader of the following quotation form?

> Of course that such a great feat has been accomplished in architectural construction does not necessarily mean that a good thing has been done as well as a big thing. If it were the production of an older civilization, it might involve or imply some such guarantee of worth, but in this country to talk thus of a public work is sure to suggest the accusation of measuring art with a yardstick and architecture by the acre. It would be easy enough to put our liberal resources of technical skill, enterprise, organization, and wealth into so stupendous a work for no higher aim than to gratify an ignorant vanity, and to no happier end than our ultimate humiliation and discouragement. Such things have happened before in the history of our progress, and a country like this would be marked for premature decay if such things did not happen in the first two or three centuries of its lusty growth.

Just what our humorist means he alone can tell, and it is not strange that immediately after these sapient remarks he should say that when the Fair was given to Chicago, "it cannot be denied that there was a general fear" of the unsatisfactory results, which "has certainly not been lessened by the report of Chicago adoption of the Brobdingnagian scale." Such criticisms of architecture, if presented by an unknown writer, would find no permanent resting-place other than the editor's waste-paper basket. It is nothing short of amazing that a periodical of the generally high character of *Scribner's* should print such stuff, or that it should send a writer to Chicago to describe the Fair who knew no more about architecture than to describe

the recessed arch placed by Mr. Sullivan as the chief feature of the Transportation Building as "Roman"! No Roman arch, either in Rome or in Chicago, was ever built like this, and, if the editor of *Scribner's* cannot find a satisfactory writer who knows such elementary elements of architecture, he would find it profitable to employ an assistant who could correct the errors of unarchitectural critics. It is not extraordinary to find among the pictures which illustrate this architectural essay a full-page picture of two ladies walking, apparently, on a seashore beach, and another of two workmen busily engaged in eating a lunch. As illustrations of the "architecture" of the World's Fair these pictures "take the Exhibition."

A DELIBERATE Congress, meeting for the sober interchange of information, yet holding sessions in which a fine pyrotechnic display was provided in the person of the Governor of the State, Colonel Ingersoll, and Henry George, certainly exhibited some novel methods, if it accomplished no other end. These unusual attractions were supplied by the National Association of Real Estate Dealers at its convention last month in Buffalo, N. Y., and their presence doubtless served to concentrate attention upon the deliberations of that body, if they performed no more useful function. As a matter of fact, this Congress merits wide attention. Real estate lies at the foundation of municipal wealth; real estate men are among the most active promoters of municipal welfare, and their efforts should not be undervalued or unappreciated even though they keep an eye on their own position, and lay up provision against a rainy day. It was strikingly characteristic of current tendencies that the larger part of the delegates should have come from the West, the East being only slimly represented. More than this, many of the men from the far West were most active in distributing documents and extolling the merits of their especial municipalities. It was quite a legitimate piece of business, and very interesting business at that, since it showed, in an unmistakable manner, the important position real estate men hold in the building up of the western cities. The connection between architecture and real estate is very close, since the value of land in a city depends largely upon the kind of building erected upon it, or which may be erected upon it. Unfortunately the sessions of the Congress were devoted more to exclusively real-estate affairs than to any topic in which the relations between architecture and real-estate were treated. It was perhaps natural that this should be so, but since the selling of lots is only the first step in the making of a city, and the building of houses a necessary second, and as, further, the dealer in land is also a dealer in houses, it would be well for this association to give architectural topics some place in their deliberations in the future. However, many of the topics treated, though some with an undeserved brevity, were of great practical value to the real-estate men, while the wide degree of public attention the Congress excited, by the application of progressive modern ideas in advertising to its method, was of signal advantage in making clear the true value of wide-awake real-estate men in the development of the country. The larger the volume of business handled by legitimate real-estate men, the greater the prosperity of the community with which they are concerned, the more solid the advance, and the more satisfactory the progress.

THE day is not far distant,—if it has not already arrived,—when architecture, so far as it affects living, will be more a matter of sanitation than of art. To a certain extent this is already true, and it will be an unquestioned advance when it is wholly so, since the preservation of human life and the catering to human health and comfort are much more the duty of the architect than the designing of soulful structures, which may be very pleasant to look at, but vastly uncomfortable as residences. The work of the thirteenth Congress of the Sanitary Institute, which met in September at Portsmouth, England, is entitled, therefore, to extended consideration from the architect. The papers read covered a wide range of subjects, and all were of great interest. The proceedings opened with a

masterly address on "The Victorian Era, the Age of Sanitation," by the president of the Congress, Sir Charles A. Cameron, the famous Irish sanitarian. He graphically traced the growth of sanitary development and reform in Great Britain during the period covered by his paper. Among the noteworthy papers was one by Sir Thomas Crawford, on "English Homes," in which he pointed out that the impression that the English people lead the world in the matters of homes as well as of sundry other things is quite without foundation. Many reforms have been instituted during the present century, but much remains to be done before the English can pride themselves as a nation upon the homes of their people. This was most admirable advice, and can well be taken to heart on this side of the Atlantic. Similar in scope to this paper was an address on the "Progress of Sanitary Engineering," delivered before the section of Engineering and Architecture by Mr. James Lemon, C. E. It treated more especially of drainage and similar questions, and claimed superiority for the English in this department, with but one competitor—America—nearly abreast. Water-supply and purification, apparatus for softening water, smoke-prevention, disposal and treatment of sewage, purity of air in stables, medical health officers, domestic hygiene,—the last a newly organized department for women,—and sundry similar subjects came in for learned and effective treatment. The Congress, as a whole, was a marked success, and was accompanied with the usual exhibition of sanitary appliances and devices.

THE World's Congress of Architects, which will form one of the numerous meetings of a similar kind at the Exposition at Chicago, will afford a welcome opportunity for the interchange of ideas among architects of all nations, which will not only be advantageous to the participants but especially helpful to the profession in America. Invitations have been extended to all architectural societies to participate on this occasion, and no effort will be spared to make it a success. It is not often that American architects, as a body, have an opportunity of meeting representative architects of other nationalities, and the forthcoming Congress, therefore, will present an unrivaled opportunity, which should be embraced by every member of the profession. Indeed there is every reason to believe that the series of Congresses on all important topics, which will be held at stated intervals throughout the Exposition, will be one of its most important and satisfactory features. In some respects the position of American architects, in a meeting of this kind, differs widely from that of foreign architects. The busy American architect does not find the time for the literary studies that characterize almost every foreign architect of distinction. The numerous architectural societies which flourish in England, France, and Germany would speedily die out in this country from lack of the necessary literary support. But however wanting the brethren may be on this score, their architectural work will convey impressions and teach lessons which the greatest literary effort might fail to accomplish. The real merits of American architecture are far from receiving the attention they deserve in foreign parts, and this Architectural Congress will do much towards placing it in its true position. It goes without saying that a vast deal of American architecture is thoroughly atrocious, but foreign architects who attend the Congress, meeting there the leading architects of the country, and personally discussing with them the conditions under which American architecture has been produced, will learn new canons of measurement, by which alone American architecture should be estimated, that will be productive of the greatest possible good. It is not the least of the many advantages of having the Fair at Chicago that the Architectural Congress will be held in the city in which American architecture has made its most important and characteristic achievements. Chicago itself will be an object lesson in American architecture that every architect, American and foreign, would do well to take to heart.

IT is not unlikely that the Exposition at Chicago will leave in that city as a me-

morial one of the richest art museums in America. The formation of museums from international exhibitions may now be accepted as a recognized fact, and they will form one of the conditions to be taken into account in determining the locality of future exhibitions. Chicago will unquestionably extract many rich plums from her show, and a great art museum seems likely to be one of them. The statement has recently been made that the French government will send a selection of casts from the great collection in the Trocadéro, the richest museum of its kind in the world, though limited chiefly to reproductions of French medieval architecture. It is hinted that this collection may remain in Chicago if half the cost of forming it—some 50,000 francs—is paid for it. It would be cheap at full cost if it is at all representative of the treasures of the Trocadéro. Every one who has visited that museum will recall the great reproductions of church doorways which form so notable a part of it. Singularly enough the molds used in making these splendid casts were destroyed, so that the Trocadéro possesses the only casts that exist. If these, or any part of them, have been re-reproduced for the Chicago Exposition, that city may well congratulate herself on her good fortune if they can be had at a reduced price. Nothing better than these models could be imagined for the nucleus of a great architectural museum, and if they can be had it would seem as though the greatest architectural museum of America would be located in Chicago instead of in New York, where it is at present. The Metropolitan Museum of New York has in its Willard collection a fairly good foundation for an architectural museum, which the trustees are endeavoring to supplement by raising an additional fund. As the Metropolitan's collection now stands, there are too many models and restorations,—Parthenon, Pantheon, Temple of Karnak, Notre Dame, etc.,—which, while well enough in their way, and serving most admirably as illustrations of the probable actual condition of the buildings they represent, are out of place in a collection intended for architectural students. It is to be hoped that this mistake will not be repeated in the Chicago museum.

CONSIDERABLE comment has been aroused over the proposed erection in Chicago of a building with a façade composed wholly of glass and aluminium, the aluminium forming the external supports, which are to be reduced to the smallest possible compass. In itself such an idea offers little for the critic of architectural design, though it is the legitimate outcome of the present tendency to enlarge the openings of all commercial structures at the expense of the wall. Since the building of commercial structures became the chief occupation of architects, as it unquestionably is in America, it seems to be only a matter of time when the opening will be everything and the construction all but invisible. Some later healthful indications seemed to indicate that a reaction had set in against this notion, and certainly the architectural value of unornamented wall space is as much appreciated and as useful in a commercial building as in one erected under less exacting conditions. But that most progressive of American communities, Chicago, comes forward with a new design, a material practically new, and invites the world to contemplate the wonder it supplies. Doubtless this may be done with profit after the proposal has been put into practical execution, but in the meantime it may be well to enter a protest against the needless condemnation of this enterprise by *The Builder* (London) because it is not architecture in any sense in which that expression has hitherto been understood in the world. Of course it is not, dear Mr. Editor, but that does not make it the less architectural. The whole tendency of American architecture is to reverse the old definitions under which the art has suffered for so long. A definition of architecture composed at the time of the Roman empire is no more binding on this progressive nation than the religious customs of that enlightened but long since passed era. An architecture of commercial buildings, of warehouses, offices, hotels, factories, and the like, such as American architecture

unquestionably is, cannot bind itself to scholastic limitations. We will admit our deficiencies, if need be, but our American architecture must be judged by American conditions, and the bookish definitions may be left to the dead past in which they originated.

THERE is no subject so interesting to the philanthropic student of economics as the housing of the poor. Tenement-houses in England and America have been explored from top to bottom, but those of other countries are not so widely known. Until the recent cholera scare,—for it was absolutely nothing but this,—the most formidable movement in emigration was among the Russian Jews. A writer in a recent number of the *Fortnightly Review* presents some information on the houses and manner of living of the poorer classes in Russia which is of special interest at this time. "In every house in St. Petersburg," quotes the writer from the *Graschdanin* newspaper, "not excluding the most magnificent, there are perennial sources of infection, perpetual cloacas, called the concierge's quarters, where even the tenant who pays £560 a year for his flat, is well aware that under his marble staircase a whole human family is hidden away in one room, in which the mother does the cooking at the moment that the children are using the place as . ." Another authority tells of a large palatial tenement house in St. Petersburg in which forty-six men, women, and children are huddled together in two little rooms. "The noisome smell at night would take away your breath. The atmosphere is positively unendurable to any but those who have grown gradually accustomed to it, and whose lungs are become coarse and hardened. Ordinary people coming into the room could not breathe it for long." In Warsaw alone there are more than fourteen thousand dvorniks, whose lodgings are so small that they allow only two by eight square meters of space for one adult and one child. "In other words, these human beings have less space to breathe in than the dead in their graves have to crumble away in. Corpses, even in Russia, receive four square meters, whereas these living, laboring men are allowed but two by eight. Sometimes the distance from the ceiling to the floor in these coffins is barely three feet; and the concierge, his wife, and his family have to crawl on all fours in order to get to the rags which form their couch, and breathe the sulphurated hydrogen which usurps the place of wholesome air." Unspeakable as these horrors are, strictly sanitary matters are far worse. "Even in our two capitals," quoting again from a Russian authority, "the method of removing refuse and impurities is so antediluvian that it would be an abuse of terms to allude to it as sanitation. In the most favorable cases the system consists in digging a big hole in the yard of every house, and throwing into it all the garbage, offal, etc., and leaving it undisturbed for months, and for longer terms than months, until at last it is carted off in boxes and barrels to some place outside the city."

CIVIL ENGINEERING.

Conducted by T. Graham Gribble.

THE report of Messrs. Corthell and Locke upon the railroad terminals of Buffalo, together with the minority report of General Field, the chairman of the Board of Works, will be of widespread interest to all who are concerned in the transportation question of our great cities. Mr. Corthell has devoted much study to the methods adopted in European cities for doing business on elevated terminals, and has contributed valuable reports on the subject as applied to Chicago. As a member of the Committee appointed by the Western Society of Civil Engineers to report upon the transportation problem of Chicago, he handed in a minority report advocating the entire elevation of the vast network of railroads in that city, and, as might have been expected, he has faced the smaller problem of Buffalo upon the same principle. To say that the report of Messrs. Corthell and Locke is both able and thorough is almost superfluous. General Field, while considering it more than the Board of Public Works is able to carry out, describes it as "a most perfect plan for eliminating the grade-crossings of Buffalo." He heartily concurs in it as an "ideal plan," but expresses the opinion that insuperable obstacles are connected with it, principally on account of the disinclination of the various railroads to combine in the execution of a great and comprehensive scheme. He therefore advises the Board to proceed with the less perfect but valuable improvements for which they have obtained powers. In the report of the Commission appointed by the City Council of Chicago, commonly known as the Dreyer Commission, the same idea of railroad combination formed a leading feature and was perhaps one of its weakest points. Until all the railroads are absorbed into the Federal Government,—which may or may never be,—any scheme resting upon a voluntary combination of such magnitude may be regarded as ideal.

We will endeavor to extract some of the most important particulars contained in the voluminous report of Messrs. Corthell and Locke, together with that of Mr. George E. Mann, chief engineer to the Department of Public Works in Buffalo. It appears that the first organized effort by the citizens in Buffalo to get rid of the grade-crossings was in 1887, when an application was made to the Board of Railroad Commissioners of the State of New York, who instructed their inspector, Mr. T. W. Spencer, to report upon the subject. Mr. Spencer's report mainly favored elevated terminals. On September 20, 1887, the chief engineers of the New York Central, Erie, Lake Shore and Western New York and Pennsylvania railroads, united in recommending a viaduct for carrying Louisiana street over the tracks; Michigan street to be protected by gates, and Chicago street to be closed. They considered Mr. Spencer's recommendations for this locality impracticable. These three streets are nearest the New York Central, Michigan street being immediately east of it. Mr. A. M. Wellington was employed by the committee to make recommendations to use before the Railroad Commissioners at a meeting held by them on October 20 to discuss the previous reports of Mr. Spencer and the railroad engineers. Mr. Wellington's report, while not in detail, was strongly in favor of raising the railroad tracks instead of the streets. His recommendations were concurred in by Mr. Albert Krause, the City Engineer, in a report to the Council, and by Mr. George E. Mann, now chief engineer to the Department of Public Works. In February, 1888, a board of engineers, composed of Messrs. John Bogart, A. M. Wellington, George E. Mann, George W. McNulty, Walter Katté, C. W. Buchholtz, and Henry Flad, met at Buffalo and recommended that in the region northeast of the Lake Shore and Michigan South-

ern railroad the grade of the streets and the railroads be readjusted in all cases so as to enable the streets to pass under the railroads; and they further recommended that in all that part of the city north and east of Exchange street plans should be prepared as soon as possible for the complete elimination of grade-crossings. Some of the more remote crossings were recommended for special treatment by means of viaducts or subways.

The present plans proposed by the Grade Commission are as follows:

Total estimated cost of structures...	$4,081,819
To this Messrs. Corthell & Locke claim that an addition should be made for land damages, alteration of grades, and for lowering the western end of the New York Central depot.....	1,918,181
Making the total cost	$6,000,000

Messrs. Corthell and Locke's report bears strongly upon the inadequacy of these plans to provide for further relief in the future, or for improvements in the present inconvenient passenger and local freight stations. They advocate at great length a complete scheme of railroad elevation, and their estimate is as follows:

For abolition of grade crossings...	$9,100,000
For improvements in terminal facilities.....	1,350,000
Total	$10,450,000

In analyzing their scheme in comparison with that of the Grade-Crossing Commission they give the following table:

Viaducts required by the plans of the Commission..... ...	17
By our plans.....	3
Subways required by the plans of the Commission	16
By our plans.....	60
Grade-crossings left by the plans of the Commission.....	28
By our plans	9
Streets to be closed by the plans of the Commission..... ..	27
By our plans.	13

General Field, in his minority report, after paying the merited tribute of praise to the Corthell report, disposes of it in these terms: "If there were no insurmountable obstacles in the way, you would, I am sure, come to a unanimous conclusion as to the best plan to be adopted, fairly considering the rights of the city and the railways. But unfortunately your honorable body faces a condition of affairs apparently not fully understood by Messrs. Corthell and Locke."

General Field's blunt "non possumus" is in striking contrast to the attitude of the municipality of Chicago. There they have come out flat-footed for elevated terminals and are in hopes that the work of the Illinois Central in raising their tracks at the World's Fair grounds will be an object lesson to the rest of the country of the feasibility of the project.

The Illinois Central people are in a very much more advantageous position than the other companies for the elevation of their tracks. Running as they do upon the Lake front, they are far less troubled with grade crossings. They do not propose to elevate their terminal, but are building a million dollar depot on the level at Twelfth street. Their work at present is an object-lesson in the costliness of a comparatively easy system to elevate. It is necessarily performed one half at a time, and the difficulties both of construction and operation are very apparent. The elevated tracks are placed upon a sand embankment with substantial stone bridges at the street crossings, the rails being gradually lifted as the sand is dumped from the flat cars. The other railroads, running as they do upon streets, would have to be placed on viaducts, and no such gradual raising would be practicable. It is difficult to see how any such plan could be carried out without complete disorganization of the train service, and it is still more difficult to form correct estimates of the cost of construction and loss of business in the interval.

MR. CORTHELL is a doughty champion of track elevation; he has lately made a report for the city of Atlanta, Georgia, in which he recommends the same complete system, including the concentration of all the railroads in a large union passenger

station. It is greatly to be hoped that he will find some city which has not gone too far with surface railroads, and is therefore in a position to make the first essay of his complete and ideal system. It is a question which affects all the great cities of this continent, and both in its legal and financial aspects, as well as in its engineering feasibility, deserves the most thorough investigation. Unless Mr. Corthell is able to demonstrate the possibility of railway companies carrying out such works at an advantage to themselves which will repay them for their work, he will be an "Athanasius contra Mundum." Railroads have come to stay and in all probability to stay where they are. Æsop has a fable of a certain lady dog who borrowed a gentleman dog's kennel while he was out on his rambles, but when he returned he found there a litter of bull pups, and out of compassion for their tender age he gave the family party a few weeks' lease of the premises. As they grew, however, it became increasingly difficult for the proprietor to effect ejection, so that he found it the best policy to submit to the situation and leave them in possession. Grade crossings must go. They are becoming every year a greater disgrace to our civilization. It is doubtful whether the car of Juggernaut ever trampled to death as many victims to superstition as the Iron Horse now crunches under the car of modern science year by year. The question is only whether to deal with the streets or the railways. The probable solution will be, where possible, the elevation of the tracks, but in most cases the changing of the street grades. Meanwhile it takes a great deal of hard work to bring the subject to its proper position in the public mind.

THE article in this MAGAZINE last month by Dr. Bayles on "Industrial Decadence in Germany" is illustrated by the following paragraph from a recent number of *Kuhlow's German Trade Review* (Berlin):

In consequence of the fall in the price of silver the Saxon Government has decided not to complete its work on the Rothschoenberger Stollen, which, if completed, would be the longest tunnel in the world. The tunnel was intended to drain the water from all the Freiberg silver mines and carry it to the Elbe. The main tunnel is nine miles long, but its branches add twenty-one miles to its length, making the total extent almost thirty miles. The tunnel was begun at State expense in 1844 and after thirty-three years of continuous work it was opened in April, 1877. Hundreds of men are thrown out of employment by the Government's decision, and it is expected that many more will follow, as the Freiberg mines cannot be worked without great loss at the present price of silver. Work in the mines was begun in 1200, and since that time the mines have produced 9,500,000 Prussian pounds—equal to 151,860,500 troy ounces—of silver.

IT appears that the contractors who have been at work on the Hudson-river tunnel have taken the Blackwall tunnel, London, at a higher price than has yet been obtained for this kind of work. The engineer's estimate was $400 per lineal foot, but the contract was awarded to Messrs. Pearson & Son for $702 per lineal foot. Whether constructors were alarmed by the cost of the Hudson-river tunnel into raising their prices or not we cannot tell, but, seeing that London clay is so very well known, it is hardly reasonable that they should make any comparison between the two conditions. The London clay affords a firm bed, and if the tubes are well grouted to prevent the clay from swelling, the pressure is quite evenly distributed. The London clay is almost perfectly impervious to water. Former tunnels have been carried across the Thames without pneumatic pressure and without any trouble with water. The new Blackwall tunnel is to be the largest yet constructed. The diameter will be 27 feet and have a brick lining 14½ inches thick inside the cast-iron tube. The St. Clair tunnel cost about $333 per lineal foot. The lining alone weighed 9333 pounds per lineal foot, and cost $135. It had no brick lining, but was driven through a clay not as stiff as that of the London basin, but having considerable supporting power.

The more recent proposals for crossing the Hudson river are those of Mr. Austin Corbin, the banker and railway magnate,

whose plan is to tunnel mainly through rock by means of very deep shafts and consequently long approaches. On the other hand several schemes are well under way for bridging the river, such as that of Mr. Lindenthal's company. Since the crucial point is that of economy, and the bridge is incontestably a preferable mode of travel, it would be greatly to the public advantage to obtain an exhaustive analysis of the rival methods of communication. The New York Rapid Transit Commission was limited in its scope, and the results obtained amounted to little more than a general review of the various schemes which are being propounded. The magnitude of the problem would warrant the outlay of a large sum upon a commission of the most eminent experts, whose duty would be to arrive at a conclusion as to the most eligible enterprise for investors. However much study may have been given to each scheme by its engineers and however close their calculations, they are necessarily *ex parte* statements. The Government engineers merely concern themselves with the headway under a proposed bridge, or with the covering over a proposed tunnel. There is no such thing yet as an independent tribunal of experts dealing comprehensively with the situation and with the best means of improving it.

THE North-river Tunnel of New York city has had a checkered and troubled history. The attempt to construct a double-track railroad in tunnel through the silt of the Hudson river has taxed the skill of engineers for about nineteen years and is still a question of to be or not to be. All that time has not been spent in construction. Litigation and delays in raising capital have consumed more time than actual work upon it. The last spurt given to the tunnel was the introduction of $1,500,000 of British capital, and with it the so-called Greathead system. This money has carried on the tunnel about half a mile, but to complete the double track road there remain some 23,600 lineal feet, including approaches. In a recent leading article, the *Engineering News* gave some interesting facts regarding the present progress, and also a theory explanatory of certain signs of weakness in the cast-iron tube which forms the lining. Our contemporary states that, though Mr. Greathead's name is given to this process of tunnelling, Sir Benjamin Baker was a prior inventor. In the *Scientific American*, when the St. Clair tunnel was being commenced, an illustrated article described this identical system as that of Mr. Beach, an American, and gave the particulars of his patents. It would be interesting to know who is really the father of this system. The *Engineering News* stated some time ago that cracks had appeared in the solid plates, causing the sides to bulge outward, and shows that the tube itself is buoyant. One thing is clear from the description of the fluidity of the silt,—that the tunnel has a very poor bed to rest on and a terribly heavy load to carry. Probably such silt as that of the Hudson river is the severest kind of test that can come upon a tunnel. There is absolutely no element of self-support about the superincumbent mass, and if there should be any yielding of the bottom it would produce bulging stresses of quite a different kind from those of an ordinary arch upon a firm foundation. Part of the tube would be acting as a girder having cumulative stresses of all kinds. The buoyancy of the tube, to which the *Engineering News* draws attention, would relieve the pressure on the bottom, and form with the resistance of the bed two forces which together would be equal and opposite to that of the superincumbent mass of silt, and of course much greater than the lateral forces.

THE harbor at Honolulu, Hawaiian Islands, has been improved lately by means of an entrance channel dredged to a depth of thirty feet and a width of 200 feet. Hitherto the larger steamers, such as those bound for China and Japan, have been compelled to anchor outside the harbor, and the war-vessels above the gunboat grade. It has been a matter of doubt for some years whether a channel could be maintained without considerable annual expense, and it still remains to be proved whether the depth now obtained will be

preserved, not only in the channel, but also in the whole of the harbor. The drainage of Honolulu is on the surface system, and the heavy freshets carry down a very large amount of detritus, which silts up over the whole harbor. For several years dredging work has been carried on, merely to maintain the former minimum depth of eighteen feet. The dredgings have been deposited on the flats of the suburbs and have not assisted the sanitation of the city. Honolulu is not the natural harbor of the Sandwich Islands. It is only of limited extent and is unprotected from Southerly gales, which have often caused much damage to shipping. The Hawaiian islands possess a magnificent natural harbor at Pearl river, which is a bunch of three elongated lagoons with a wide and deep water space perfectly protected from all storms. The only obstacle to the development of this harbor is a coral bar, the removal of which would cost a sum estimated at from $300,000 to $2,000,000. The exclusive right to create this harbor was granted to the United States by the Hawaiian government several years ago. Although a protest was made by Great Britain, the concession was sustained by the Hawaiian government, but for some reason the United States have taken no action in the matter, probably because they think they can have the islands whenever they want them.

The special feature of engineering interest in the work just completed at Honolulu is the method of dredging adopted in the heavy swell of the Pacific ocean. A Von Schmidt dredger, built conjointly by the Risdon Ironworks and the San Francisco Bridge Co., was constructed especially for the work at a cost of $65,000. It is a flat-bottomed scow, 100 feet long by 40 wide, and 9 feet deep, carrying a centrifugal pump driven by a pair of compound condensing engines. The material of the bottom was coral sand. The scow was moored to several anchors, and a loose suction pipe was hung on chains from the forward projecting frame, having a vertical plug of fourteen feet. From August 12 to August 27 the work was carried on night and day, and at the latter date work for a week or two remained to complete the channel. The Government will proceed with the whole of the harbor in the same manner. The consulting engineer was the well-known hydraulic engineer of the Pacific Coast, G. F. Allardt.

THE largest warship afloat is the *Royal Sovereign*. At her recent trial-trip she kept up a speed of 18.1 knots per hour for three hours. Her displacement is 14,150 tons, which is nearly 3000 tons more than that of the *Inflexible*, the next largest vessel of the British fleet. Italy has five ships afloat whose displacement is nearly as large as that of the *Royal Sovereign*, and she finds them an expensive luxury. The later battle-ships of the United States Navy, the *Indiana*, *Massachusetts*, and *Oregon*, are of 4000 tons less displacement than the *Royal Sovereign* and their estimated speed three knots less. The armament of this latest floating battery exhibits the change of opinion which has taken place of late years among warship builders. The *Royal Sovereign* carries 67-ton guns, and our three battle-ships only carry 45-ton guns. The Italian men-of-war are armed with 100-ton guns, and the British *Inflexible* carries 80-ton guns. This lessening of the weight of the projectile is due to the opinion that no vessel can be built to endure the concussion of the fire of very heavy guns without splitting her plates. It is considered unquestionable that the Italian ships would wrench themselves apart in action long before they had destroyed the enemy. The spectacle of nations thus draining their resources for the creation and maintenance of these prodigious engines of destruction, which become obsolete before they can be used, is the best demonstration of the wisdom of the Quakers.

MINING AND METALLURGY.

Conducted by Albert Williams, Jr.

THERE used to be a prevailing impression that metalliferous veins, especially those carrying gold and silver, grow richer with depth. This belief was consistent with the theory which ascribed the origin of such ore deposits wholly to ascending solutions from deep-seated sources. If that theory held good for all or most vein deposits, it would be only natural to expect that the nearer one went to the original source—that is, by sinking—the better ought to be the ore. Consequently, if one could only go down far enough, he ought to reach in time a veritable treasure-house of native metal or at least a solid mass of ore from which the mineral in the vein above was a mere offshoot. The ascension theory is now reduced within narrow limitations, and with its restriction the notion of richness increasing with depth loses most of the credit which it might have derived from pure theory, apart from observed facts. There have been other prejudices current, directly opposite to this—namely, that certain kinds of vein deposits do not "go down"—and no better founded. This shows that it may be as unsafe to generalize from too few facts or imperfect observation as it is to begin at the other end and reason from a shaky theory to probabilities. Plenty of veins rich at the surface have become too poor to work at moderate depths, the formation continuing regular so far as followed, but the ore failing. In such cases work is usually abandoned long before it is known positively that there is nothing farther down; hence they do not establish anything like a true generalization. Nor, on the other side, do we get much light from the veins that are poor at the surface and which might turn out well in depth, for the simple reason that they do not usually afford sufficient encouragement at the outset to lead miners to follow them down. Yet, on the whole, both as an abstract proposition and as a working rule, miners are more ready to entertain a feeling that depth means increase in richness than they are to lean the other way.

BELOW the zone of surface agencies there is no general rule whatever,—at least none that has been found out, though within a limited district the more deeply developed mines do give an inkling of the probabilities in extending the shallower ones. Some mines become richer, some poorer, in descending; some are fairly uniform, and more are decidedly spotted and irregular. There is a reason why, just at the surface, where a natural concentration of the heavy ore minerals may have been going on during ages of erosion, ores of certain kinds should be richer as well as freer; for what is left may represent part of the concentrated detritus from the upper portions of a mass that has disappeared. Chemical action may have worked either for or against the enrichment of the croppings, according to the nature of the case. So two extremes are met, of which the most common examples are the auriferous pyrite veins whose oxidized croppings are on the average better than the unaltered portions below, and veins whose ore minerals (as in some copper mines) oxidize to soluble forms that are leached out and lost from the exposed upper part. There is no mystery about these atmospheric and chemical changes. So far as the relations between the character of the croppings and that of the undecomposed vein immediately underlying are concerned, a number of quite safe deductions have been established; so generally accepted indeed that they are taken into consideration in projecting mine development and serve to warn against the mistakes in designing metallurgical plant which were so frequent and costly in times when they were disregarded. All intelli-

gent miners now have an idea of the general law of transitions from oxidized to sulphid ores. The trouble is that they sometimes act as though they had forgotten it.

DISREGARDING those alterations which are to be expected above the permanent water-line, and giving attention for the moment to the unaltered parts of veins below, there would be less confusion of ideas if it were borne in mind that veins within range of mining exploration offer only a small section of their total depth. This section, for such as have been formed in comparatively late geological times, may be a slice representing practically the top of the whole formation as it existed at the time when the veins were formed, or it may be a part that was originally many thousands of feet down, the rest having been long since carried away by weathering and erosion. Sometimes not only the age of the inclosing country rocks but also the approximate geological date of the vein-making are known, and an enormous amount of cutting down is shown actually by the quantity of "wash" in the vicinity to be accounted for, as well as inferentially from the time that has elapsed. A wear and tear of a fraction of an inch a year counts up into the thousands of feet without going very far back in geological time. Is it any wonder, then, that under such diverse conditions, and considering the very limited exposure to be got at by mining, there should be all sorts of irregularities in the vertical distribution of ore? Yet in practical application this point is lost sight of altogether. If one stops to think that opening the 500-foot or the 1000-foot or the 3000-foot level of a mine doesn't make much difference so far as geological conditions go, considering that he may be already down 10,000 or 20,000 or more feet on the vein as it once was, there is no danger of being misled by any prejudice in favor of pushing downward at any cost, for the mere sake of gaining depth regardless of other considerations. There are good technical reasons for desiring to open a mine deeply,—for the sake of exploration, to give plenty of room for stoping, to block out large ore reserves, or to drain the upper workings. But because a mine may be richer at lower than at upper levels is seldom one of them. Unless there is a positive indication (as, for example, a defined ore chute) which points to better chances downward than laterally,—that is, when underground prospecting is pretty much blind guessing,—it seems reasonable to develop by drifting rather than by sinking, other things being equal, since several feet of levels can be driven to every foot of shaft sunk. It is somewhat astonishing to find, especially in those few company mines having abundant working capital, that the more expensive and slower plan is so often preferred, upper levels being abandoned before half explored, while disproportionate shafts are sunk on general principles. Superintendents are rightly impressed with the desirability of keeping exploration well ahead of the stopes; but they sometimes seem to take the rule to apply vertically only and not both ways. When a mine manager is so fortunate as to be able to choose in which direction to devote his main energies, and there is no special reason otherwise, why not take the easier way?

FORTUNATELY for the prospector and the miner, it is not necessary to sink through resisting rock to reach strata which are really very low in the stratigraphical series. In some cases the archæan rocks, having remained above water from the earliest geological periods, have never been built upon by deposition of later strata; in others, erosion has cut deeply into the upper members of the series, laying bare vertical sections of thousands of feet; in still others, dynamic agencies have tilted the beds so that the surface exposure may represent a total stratigraphical depth of perhaps 50,000 feet, or erosion and tilting may have acted in concert to accentuate these effects. It would be a great convenience for both prospecting and mining if there were more natural sections like those of the cañons of the Colorado and the Grand, with sheer walls of 2000 to 6000 feet showing like the ideal diagrams in the text-

books. Yet the existing arrangement cannot be complained of, considering that in the mountainous regions, where vein-deposits are not only most readily found but also most likely to exist, the natural exposures are very great, even if not always presented like a panorama to be viewed through a field-glass. All this is matter of common knowledge; yet few people (miners included) fully realize, when discussing problems of deep mining, that in reality the deepest shafts, the longest adits, are but puny affairs compared with the development work which nature has been kind enough to carry out.

UNDERGROUND haulage has not yet received the attention in metal mining that it deserves. True, the quantities to be handled are usually much less than in coal mining; but there are many mines in low-grade metalliferous deposits where operations have to be prosecuted on an extensive scale in order to be profitable, and where the ore movement is very considerable. This opens a field which the electricians have not been slow to examine and work upon. It would not be surprising if, in the course of a short time, we should see electricity adopted very generally for underground haulage in the larger metal mines. The great iron and copper mines offer the most promising opening, and next the low-grade precious-metal mines and those which are adopting complete electric plants for other purposes. Electricity is not, however, the only expedient. There are several old and tried, as well as new and promising, systems of other kinds to choose from. Of the existing methods of mechanical haulage both the endless rope and the tail rope systems are applicable under the proper conditions. Progressive miners are becoming dissatisfied with the handcar and the primitive but persistent wheelbarrow, and do not regard mule-power as much of an improvement upon man-power. On the other hand, hoisting in shafts has been carried in the best practice to a high degree of efficiency, so far as we are able to judge of its possibilities, while accidents connected with hoisting machinery are not very frequent. But then there is the expense. Economy and speed in underground haulage will have much to do with the choice of the general plan of development of mines, and will bear directly upon the vexed contention of adit versus shaft.

LITTLE has been heard lately about a scheme for rapid shaft-sinking which excited much interest a few years ago. That was the plan of putting down a complete set of drill-holes to the full depth of the proposed shaft by means of the diamond core drill or by the use of a drilling apparatus like that employed in sinking bore-wells for brine, petroleum, and natural gas; doing all the drilling at once; filling the drill-holes with sand, then removing the filling section by section, blasting, hoisting out the broken rock, and repeating the process until the whole excavation was finished. One notable example was afforded of a large shaft for a coal mine being sunk in this way, the holes being bored continuously by diamond drills; but the record was not sufficiently encouraging to bring the method into general favor. There are some evident disadvantages in the system. Parallel holes do not offer the best chance for the explosive; and if short supplementary converging holes had to be added afterward at each stage, leaving only the side holes for the continuous-drilling method, there would be no apparent gain from the latter. It would be difficult to send the holes down in true alignment, and if made by the well-drilling apparatus they would be inconveniently large in bore for effective tamping. Perhaps a single very large and open bore-hole, drilled by an exaggerated form of the diamond core drill (as already suggested in these pages), sunk in the axis of a proposed shaft, might assist by giving a central release for shots in the exterior lines.

MOST of the mining States prohibit by law the employment of boys under fifteen years or under sixteen years of age in the mines. The agents of the last Census were able to discover only 82 boys under sixteen in the gold and silver mines; and it goes without saying that they found no

women there, unless indeed they might have counted in a stray type-writer girl or two in the offices as belonging to the mine force. As to boys' labor, there are perhaps some sturdy lads of fifteen able to do men's work; but as a rule when boys are employed in our mines they are set at light duties, as carrying tools, and it is a question whether they should be prevented by law from earning a livelihood and learning the rudiments of the trade in this way, so long as they are not overtasked. As in other similar cases, enlightened public sentiment may usually be counted on to repress inhumanity; but on the other hand, in view of the mistaken idea of economy and lack of intelligent self-interest evinced by the employment of inefficient imported contract labor and leased convict labor by some mine managers, it may be just as well to let public opinion find expression in the restrictive statutes which exist, pending the evolutionary development of human nature to a point where such matters can be regulated without need of the written law.

One of our ultra-patriotic daily newspapers of the class so obstreperously prone to making invidious international comparisons, having heard that there were 4456 women employed "under the coal-mines regulation act" in Great Britain last year, proceeds to indulge in buncombe about the barbarity of allowing women to work in the English mines, evidently not knowing that the women so enumerated were employed at the surface as coal-pickers, etc., and that female labor underground is happily a thing of the past there, though not yet done away with in some of the mining countries of the Continent.

Public opinion in civilized countries probably will suffice in time to remove the last vestiges of the old custom of having women and children at work underground or anywhere else at labor unsuited to them, without the intervention of laws. If however, the moral force is not yet strong enough, "the legislative superstition" is strong enough to bring forward those who may find it expedient to make the change legally compulsory and in consequence abruptly. That is a matter which each country will regulate for itself. Volunteered criticism from the outside, especially when offered without a full understanding of local economic and social conditions, can hardly be expected to carry much weight. We here have our own little shortcomings to look after and amend—as for instance the company-store squeeze, imported contract and convict labor (not yet wholly abolished, despite laws and protests), and other provocatives to labor troubles—before we can preach with a good grace to foreign nations.

CURRENT USAGE is tending toward uniformity in designating mining engineers by the title "E. M.," in contradistinction to that of "M. E.," which has passed by general consent to the mechanical engineers. To avoid confusion it would be well if the practice were at once made wholly consistent, since the ultimate tendency is so plain. The mining engineers may have had the original right of way, but there is no contest, no preëmption about it. Nor is it a matter of overwhelming importance to decide who may use either title. If graduation from a technical school is made the criterion, and if there were any way of enforcing a rule, some ignoramuses might be shut off from the rather empty honors, but at the same time many competent engineers who had learned their profession outside of the schools would also be disrated. After all, titles are so cheap in this country that they count for little unless it is understood how they are acquired. Almost anybody can get a "Ph. D.," for example, by running after it long enough and accepting it from a female seminary as a last resort. The criteria of engineering, in all its branches, differ from those applied in the practice of medicine in this: An engineer's work speaks for itself; good or bad, there is always something tangible to refer to, and it is immaterial whether he got his elementary training in school or out; but you cannot gage a physician's skill or want of it by any such direct test, and hence there is some sense, as a matter of public safety, in jealously guarding the title of

"M. D.,"—which doesn't mean very much, to be sure, except that the holder has had at least the opportunity of learning something. As for mining engineering, it would be difficult to draw the lines, since the requirements are so varied and irregular. If any test were attempted, it ought to be a pretty stiff one; something like, only more searching than, the examination and certification sometimes applied to mine inspectors and foremen in coal-mining regions. As the case stands now, not only the graduate engineers, but all who please, sport the "E. M." Men of any standing don't need the two-letter suffix; and the others don't gain much by it. It is simply a convenient way of designating one's business, just like hanging out a shingle.

TECHNICAL training for mining and metallurgical work is a good thing, a very good thing indeed, and not to be sneered at as mere book-knowledge. At the lowest rating it implies, or ought to imply, a saving in time and trouble in getting on the right track, and an avoidance of certain errors and misdirection of effort attending self-education without proper guidance. But the technical schools do not turn out ready-made engineers and metallurgists in the full acceptation of these terms. For that, some practical experience and perhaps also a rather more mature judgment are necessary. What the schools really do, and what is all that can be reasonably expected of them, is to give a solid grounding in the arts involved, and a smattering of "pure" science bearing upon the principles to be applied in practice. They graduate fair surveyors, draftsmen, and assayers, ready to fill at once subordinate positions about a mine or a metallurgical works acceptably, or to enter into independent business in these lines. The graduates, later on, win for themselves more responsible and better-paying berths, after proving their competency in the lower grades. That is to say, after leaving the schools, their future is pretty much in their own hands, and the real work is only beginning. They start in the competition with a "percentage" over untrained men, but that alone is not enough. No young student should look forward to stepping directly from the school to the charge of a big mine or works, with a large force under him, large output and expenses, large responsibilities of judgment, and a salary of $6000 or upward,—for he will be disappointed, unless a confiding parent owns the whole outfit and doesn't know any better than to trust him to run it offhand.

AT such of the mining schools as accounts have been received from it appears that the Fall term opened with large classes of new students. Mining and metallurgy are becoming more attractive to the young men who are making choice of a profession, the result being that the schools are turning out a large number of graduates yearly. Among the older men there is some grumbling about the imaginary overcrowding of the profession, as is usual and to be expected. But there is always plenty of room for the new-comers in the subordinate capacities in regular work. The main thing for them is to recognize the character of the field that is open. As for the "expert" business, the competition is that of reputation, not of numbers.

IT is well understood that the speed at which rolls are driven is a very important factor of their capacity, the latter depending almost wholly (assuming that proportionate power is supplied) on the three elements of speed, width of face, and diameter, or in other words, upon the total area of crushing surface utilized during a given period of time. The character of metal in the shells, the condition of the wearing faces, and the weight also affect the result, though indeterminably; and no doubt the diameter has an additional effect, beyond that owing to the mere extent of surface presented, by determining the tangential angles of the two roll faces just above the point of nearest approach. Perhaps too little attention has been given to the development of high speed, though this may be accounted for by the fact that in most metallurgical establishments of moderate capacity, as the sampling

works and many of the concentrating plants, the breakers and rolls are put in with a considerable margin of excess above the capacity of the remainder of the plant. Yet it seems a pity to see the large rolls, with their recent improvements in adjustment, feed, safety-reliefs, and superior metal, driven at a much lower speed than is practicable. A few sets of rolls of one make are run at 100 revolutions or more per minute, but usually the speed is only 50 and sometimes less. A 36-inch roll gives about 9.42 square feet per revolution for each inch in width of face, or a circumferential velocity of 471 feet per minute at 50, and 1413 feet at 150, revolutions. There are limitations both as to width and diameter, the former being seldom more than 16, 18, or 20 inches, and the latter being considered very large if 45 or 48 inches. But with the improved construction and with self-feeding apparatus to distribute evenly across the width and adjusted to keep up with the speed, the average speed could doubtless be trebled for strongly built machines, and with an expenditure of power by no means proportionate to the gain.

Increasing the capacity of rolls might not greatly extend their use for the purposes to which they are usually put in small plants, where they would be preferably adopted for other reasons in any event; but it might have considerable influence in affecting their choice for some of the large coarse-concentration plants to be built in the future. Present practice has not advanced beyond the 3000-tons-a-day mill of the Anaconda copper mines, with its fourteen steam stamps, and it may be long before another such plant is erected; but many more concentration mills of 100-ton capacity and upward are certain to be built. For coarse concentration, the rolls ought to hold their own against other devices on account of their granulating effect with the minimum of pulverizing and consequent sliming. They are not adapted to fine crushing except by gradual reduction, and then tediously and not very well. But in their own field they still have a firm hold, notwithstanding the keen competition of other devices. Rolls are one of the three older types of mechanisms used in metallurgy which have not yet been wholly supplanted and driven out by more recent inventions, —the other two being the gravity stamp and the jig. All three have been modified and improved; but their essential principles still hold good in the best modern practice, though their limitations are better recognized.

WITH the gradual exhaustion of the upper coal seams in Europe it is found necessary to resort to those at greater depths. In England some very deep coal-mining is being done; but this is particularly true in Belgium, where, in the Mons district, shafts have lately been sunk to a depth of 3775 feet. At this depth the mining is done at great disadvantage, not so much on account of the increased cost of hoisting and the added pressure to be provided against, as because of the large volumes of water to be handled and dangerous flows of gas. A product like coal has to be mined with the closest economy to obtain a profit, in view of the small value in proportion to bulk. In this country, fortunately, we have not yet been compelled to go down very deep after coal, and so far most of our coal mines are relatively shallow, in the West more so than in the East. But it is only a question of time, shorter or longer, when, as the more accessible beds are worked out, the existing situation of European coal-mining will be repeated here. The popular conception that our easily available coal reserves are "practically inexhaustible" needs rectifying.

CORUNDUM is found in scattered pockets in a number of States. The domestic output, which amounts to from 500 to over 2000 tons a year, comes from Massachusetts, New York, North Carolina, South Carolina, and Georgia. No one seems to prospect for this substance or emery, which, though they usually occur in small quantities, command a good price. It is very likely that there are many undiscovered localities, since either mineral would easily escape identification.

MINERS and quarrymen have some things to learn from each other. Their occupations appear to be quite distinct, yet in many respects they overlap. There are many open-cut mines, and a few quarries that come near being mines. Miners may find in the best equipped and most skilfully managed quarries examples of what can be done by power drills working under the most favorable conditions, of the economical use of explosives and the adjustment of work according to the cleavage and grain of rock, of the handling of heavy materials at the surface, and special tricks about stripping, disposal of waste, etc. Quarrymen, on the other hand, should not be too sensitive to acknowledge that they are not, as a class, perhaps quite so progressive as their troglodyte cousins, a little less ready to adopt new methods and new ideas. There are quarries and quarries, quarrymen and quarrymen. Some of the great quarries are operated with a high degree of technical skill, but too many of them are run in the style of the contractor rather than that of the engineer. It is not a matter of "style" alone, for in the one case just as in the other the ultimate aim is of course always commercial success; but in the majority of quarries one sees a disproportionate amount of hand labor, and many things being done by methods very creditable to the ancient Egyptians, who had no end of that kind of power for board without lodging, but not much else to work with. Great results can be accomplished by use of the crowbar, the roller, and the inclined plane, now as then, and quarrymen are wonderfully ingenious in getting the most possible out of muscle. But we rather fancy that those old fellows who built the pyramids and the other big monuments and buildings would have been very glad to avail themselves of steam derricks, railroad tracks, tramways, and other nineteenth-century contraptions wherever these would have proved more economical than even slave power. Now a modern miner, if placed in charge of a modern quarry, would at the go-off instinctively clamor for "capital" and "machinery" and "development." He would very likely go too far in this direction and would find that he had a good deal to learn about quarrying as a business and might have to come down a peg; but he would try to give his quarry the same show that he would a mine.

FROM time to time the desirability is urged of substituting some shorter name for the metal aluminum. In its present form the word is rather clumsy, though no worse than that of another common element, manganese. The American spelling differs from the European custom of giving it the full "-ium" termination, gaining slightly in brevity. None of the suggestions yet made for cutting the word down further, or for making a new one, have elicited any wild enthusiasm. One writer proposes "allit," retaining the "al" of the chemical symbol and adding "lit" as a contraction for "light"; another suffixes the metallic termination "-um" to the root, and offers "aluüm"; a third votes for "almin," and so on. Perhaps the most sensible suggestion is one that was put forward in jest—to call it simply "al." There is of course no imperative call for any change and no need for shocking the lexicographers. But as aluminum, while thus far somewhat disappointing as the metal of the future, is nevertheless coming into everyday use as the material of familiar objects, it might be urged that the world would save a few cents' worth of time, breath, and printers' ink daily by adopting some sawed-off form of the old word or inventing a new one. Here is an open field for glory to the genius who can find something as short as "iron," "steel," "lead," "tin," or "zinc," that will be significant and not grotesque, and that other people will adopt.

CURRENT TECHNICAL LITERATURE.

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In the body of the index the initials of the papers quoted are given, and these can be readily identified by the alphabetical list of periodicals below. Other abbreviations are: Ill=Illustrated; w=words.

THE AMERICAN PRESS.

A S .....Age of Steel. *w.* $3. St. Louis.
A An.... American Analyst. *f.* $1 per year. N. Y.
A A.....American Architect. *w.* $6. Boston.
A Ar.....American Artisan. *w.* $2. Chicago.
A C J....Am. Chemical Journal. *b-m.* $4. Baltimore.
A D.....American Druggist. *m.* $1.50. New York.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..American Journal of Railway Appliances. *m.* $2 per year. New York.
A M .....American Machinist. *w.* $3. New York.
A M & I W.American Manufacturer and Iron World. *w.* $4 per year. Pittsburg.
Am M....American Miller. *m.* $2. Chicago.
Am S....American Shipbuilder. *w.* $2. N. Y.
A A A....Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A H.....Annals of Hygiene. *m.* $2 per year. Phila.
A E .....Architectural Era. *m.* $3. N. Y.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A & B....Architecture and Building. *w.* $6 N. Y.
A .....Arena. *m.* $5 per year. Boston.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3 per year. Washington.
At M.....Atlantic Monthly. *m.* $4 per year. Boston.
B J C....Boston Journal of Commerce *w.* $3 per year. Boston.
B & W...Builder and Woodworker. *m.* $1. N. Y.
B P .....Bulletin of Pharmacy. *m.* $1. Detroit.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A..Canadian Architect. *m.* $2. Toronto.
C E N....Canadian Electrical News. *m.* $1 per year. Toronto.
C & B...Carpentry and Building. *m.* $1. New York.
C M.....Century Magazine. *m.* $4 per year. N. Y.
Ch.....Chautauquan. *m.* $2. Meadville, Pa.
C E. .....Colliery Engineer. *m.* $2. Scranton, Pa.
C.....Compass. *m.* $2 per year. New York.
Cos.....Cosmopolitan. *m.* $3 per year. New York.
Cr.....Crank. *m.* $1.25 per year. Ithaca, N. Y.
D E.....Domestic Engineering. *m.* $1. Chicago.
D J .....Drainage Journal. *m.* $1. Indianapolis.
D Jour..Druggists' Journal. *m.* $1. Chicago.
E A .....Electrical Age. *w.* $3 per year. New York.
E E N Y..Electrical Engineer. *w.* $3 per year. N. Y.
E I.....Electrical Industries. *m.* $3. Chicago.
E R N Y..Electrical Review. *w.* $3 per year. N. Y.
E W .....Electrical World *w.* $3 per year. N. Y.
E N Y....Electricity. *w.* $2.50. N. Y.
E & R ...Electricity and Railroading. *m.* $1 per year. Boston.
Eng .....Engineer. *s-m.* $2 per year. New York.
E M J....Engineering and Mining Journal. *w.* $4 per year. New York.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M.....Engineering Mechanics. *m.* $2. Phila.
E N.....Engineering News *w.* $5 per year N Y.
F & M R..Financial and Mining Record. *w.* $3 N.Y.
F W.....Fire and Water. *w.* $3 per year N.Y.
F.....Forum. *m.* $5 per year. New York.
G & F....Garden and Forest. *w.* $4 per year N Y
G G M...Goldthwaite's Geographical Magazine. *m* $2 per year. N.Y.
G R.....Good Roads. *m.* $2 per year. N. Y.
I A.....Inland Architect. *m* $5 per year. Chicago.
I R W...India Rubber World. *m.* $3 per year. N.Y.
I S F.....Industry. *m.* $2 per year. San Francisco.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age. *w.* $4.50. N. Y.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A C S..Journal of the American Chemical Society. *m.* $5 per year. N. Y.
J A E S. Journal of the Association of Engineering Societies. *m.* $3 per year. Chicago.
J F I.....Journal of the Franklin Institute. *m.* $5 per year. Philadelphia.
J M S I..Journal of the Military Service Institution. *b-m.* $4 per year. Governor's Island, N. Y. H.
J N E W.Journal of the N. E. Waterworks Association. *q.* $2. New London. Conn.
J U S A..Journal of the United States Artillery. *q.* $2.50. Fort Monroe, Va.
L M.....Leather Manufacturer. *m.* $3. N. Y.
L E.....Locomotive Engineering. *m.* $2. N. Y.
M & B..Manufacturer and Builder. *m.* $1.50. N. Y.
M R.....Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M N.....Mechanical News. *s-m.* $1.50. New York.
M & El ..Mechanic and Electrician. *w.* $2 per year. St. Louis.
Met W...Metal Worker. *w.* $2 per year. N. Y.
Min .....Minerals. *m.* $1 per year. N. Y.
M S P....Mining and Scientific Press. *w.* $3 per year. San Francisco, Cal.
M S R....Mining and Scientific Review. *w.* $2 per year. Denver.
M I T....Mining Industry and Tradesman. *w.* $3 per year. Denver.
Misc.....Miscellaneous.
N B .....National Builder. *m.* $3. Chicago.
N C B...National Car Builder. *m.* $2. N. Y.
N A R...North American Review. *m.* $5. N. Y
N W.....Northwestern Architect. *m.* $3. Minneapolis.
N M. ..Northwestern Mechanic. *m.* $1. Minneapolis.
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*7322. Les Dynamos à Poles Alternés Intérieurs et Extérieurs, Systèmes Kœchlin et Mariotti. Ill. A. Palaz (El P-Oct. 1) 2000 w.

*7323. Sur Quelques Points Relatifs à la Construction des Transformateurs et au Réglage de la Tension dans les Réseaux à Courants Alternatifs. E. Meylan (El P-Oct. 1.) 1000 w.

7332. Preparation for Electrically Utilizing the Power of Niagara. Ill. (W E-Oct. 15) 2500 w.

7333. Giraud's Thermo-Electric Battery. Ill. (W E-Oct. 15.) 2400 w.

ELECTRIC LIGHTING.

*6627. Relative Cost of Gas and Electricity. C. J. Russell Humphreys (E Mag-Nov.) 3000 w.

6635. Irish's Thermal Arc Lamp Regulator. Ill. (E E N Y-Sept. 14.) 800 w.

6637. The Electric Illumination of the Secteur Popp in Paris. Ernst Egger (E E N Y-Sept. 14.) 2000 w.

6640. The Manufacture of High Voltage Incandescent Lamps. Henry E. Vineing (E E N Y-Sept. 14.) 700 w.

*6698. A New Miner's Electric Lamp. (I-Sept. 9.) 350 w.

*6709. Electric Light and Power. I. Arthur F. Guy (E E L-Sept. 9.) 2500 w.

*6712. Electric Lighting in London. Ill. (Eng L-Sept. 9.) 3500 w.

*6750. Recent Tests of Glow Lamps (E L-Sept. 9.) 1000 w.

*6874. Electric Light and Power. Arthur F. Guy (E E L-Sept. 16.) 3000 w.

*6889. Practical Electrical Units and Electric Light Calculations (M W-Sept. 16.) 1200 w.

*6900. The Supply of Electricity in Dublin. Ill. (E R L-Sept. 16.) 3500 w.

6925. The Mount Washington Search Light. Ill. A. C. Shaw (E E N Y-Sept. 28.) 2000 w.

6943. Electric Lighting and the Telephone in Japan. S. Kalogi (E A-Oct. 1.) 500 w.

6946. Electric Light Companies as Manufacturing Corporations (W E-Oct. 1.) 450 w.

*6996. The Lighting of Billiter Buildings. Ill. (E-Sept. 23.) 400 w.

*7015. On the Manufacture of Incandescent Electric Lamps. Frederick Graham Ansell (E E L-Sept. 23.) 2500 w.

*7016. Electric Light and Power. II. Arthur F. Guy (E E L-Sept. 23.) 1800 w.

7072. Decision of the U. S. Court of Appeals in the Edison Electric Lamp Case (E W-Oct. 8.) 7000 w.

*7162. Consulting Engineering (E P-Oct. 1.) 1200 w.

*7172. Investigation of the Energy Consumed by Incandescent Lamps. Ill. Ch. Hauptmann (El-Sept. 30.) 1000 w.

*7180. The Supply of Electricity for Frankfort-on-the-Main. Ill. (Eng L-Sept. 30) 3000 w.

*7186. Notes on the Fitting Up of Ships with the Electric Light. Alfred H. Gibbings (E L-Sept. 30.) 2000 w.

*7187. Electric Light and Power. III. Arthur F. Guy (E E L-Sept. 30.) 1500 w.

*7188. On the Manufacture of Incandescent Electric Lamps. Ill. Frederick Graham Ansell (E E L-Sept. 30.) 800 w.

*7189. Flashing. Editorial (E E L-Sept. 30.) 800 w.

*7212. Eclairage Electrique de la Ville du Havre. Ill. G. L. (G C-Sept. 17.) 2900 w.

*7224. Transformateurs de la Société d' Eclairage Electrique. Ill. F. Géraldy (Elec-Sept. 15.) 2700 w.

*7236. Etude sur la Consommation des Lampes à Incandescence. Ill. Ch. Haubtmann (El P-Sept. 24.) 4000 w.

7269. Electric Lights on a Coral Reef. Ill. (E R N Y-Oct. 15.) 1400 w.

7274. Rules, Formulæ, and Tables for Incandescent Wiring. W. D. Weaver (E W-Oct. 15.) 1500 w.

GAS ENGINEERING.

*6716. The New Welsbach Lamp. Herr Bössner (G W-Sept. 10.) 1400 w.

*6717. The Gas Stove Trade Lux (G W-Sept. 10.) 2500 w.

6734. Some Practical Remarks upon the Operation of the Lowe Double Superheater Setting. J. A. P. Crisfield (P A-Sept. 15.) 700 w.

6747. Lighting and Air Contaminations. Dr Ferd Fischer (A G L J-Sept. 19.) 900 w.

6748. The Wilkinson Water Gas Plant at the Works of the Milwaukee (Wis.) Gas Light Company. Ill. (A G L J-Sept. 19.) 1000 w.

6749. Scharfe's Purifier and Condenser. Ill. (A G L J-Sept. 19.) 2500 w.

*6808. Coke and the Coke Market (J G L-Sept. 13.) 2500 w.

*6837. The Production of Coke in the United States (C G-Sept. 16.) 1000 w.

*6851. Municipal Gas Works. Edward W. Bemis (Ch-Oct.) 2500 w.

*6868. The Gas Stove Trade. Lux (G W-Sept. 17.) 1200 w.

*6869. E. C. Riley's Inaugural' Address (G W-Sept. 17.) 4500 w.

6892. Inferiority of Australian Coke (A G L J-Sept. 26.) 1000 w.

6942. A Bibliography of Coal Gas (J G L-Sept. 20.) 2000 w.

*6983. Carbonizing Methods, Past and Present. I. W. I. Carpenter (G W-Sept. 24.) 1800 w.

*6984. Rates of Wages in Gas Works (G W-Sept. 24.) 5000 w.

*7022. Cannel Gas. Editorial (Eng L-Sept. 23.) 2000 w.

*7023. The Apotheosis of the Producer (Eng L-Sept. 23.) 2500 w.

7026. Coke and the Coke Market (A G L J-Oct. 3.) 2500 w.

7027. The Elkins and Bolklen Gas-Making Apparatus. Ill. (A G L J-Oct. 3.) 2000 w.

7035. Gas Commissioner Parker's Visit to European Gas Works (P A-Oct. 1.) 1500 w.

7140. Pres. Irving's Address before t Southwest of England District Association of Gas Managers (A G L J-Oct. 10.) 5000 w.

*7148. Oxygen Purification. Leicester Greville (J G L-Sept. 27.) 1800 w.

7149. The National Heat and Power Company's Fuel Gas Process. Ill. (A M & I W-Oct. 7.) 1200 w.

*7164. Heat in the Production of Fuel Gas (G W-Oct. 1.) 450 w.

*7165. Iron in Gas (G W-Oct. 1.) 500 w.

*7166. Alkali Works, etc. Annual Report (G W-Oct. 1.) 3500 w.

*7167. Carbonizing Methods, Past and Present. II. (G W-Oct. 1.) 2500 w.

*7177. Recovery of Sulphate of Ammonia from Blast Furnaces. B. H. Thwaite (I L-Sept. 30.) 1000 w.

*7290. Notes on Asphalt Paving. H. Tobey (J G L-Oct. 4.)

*7292. The Measurement of Pressure Produced in Gaseous Explosions. B. Lean and W. Bone (J G L-Oct. 4.) 800 w.

HYDRAULICS.

6664. Atlanta Has the Cheapest Water Rates South. I. W. Avery (M R-Sept. 16.) 600 w.

6787. The Extended Use of the Hydraulic Ram (E N-Sept. 22.) 1200 w.

6819. Filtration of Water. I. Ill. (Met W-Sept. 24.) 2500 w.

*6824. The Cardiff New Water Works (E-Sept. 16.) 1000 w.

6831. James B. Francis (B J C-Sept. 24.) 900 w.

*6845. The New Taff Fawr Waterworks for Cardiff (I L-Sept. 16.) 3000 w.

*6872. Cardiff Water Supply. Ill. (Eng. L-Sept. 16.) 1500 w.

†6923. Victorian Water Supply (I E-Aug. 27.) 600 w.

6931. Movements of Water over a Dam with Wide Horizontal Top. Jos. P. Frizell (E N-Sept. 29) 600 w.

6933. Irrigation System of the Cucamonga Fruit Land Co., San Bernardino Co., Cal. Ill. Geo. F. Wright (E N-Sept. 29.) 3500 w.

6939. Irrigation of the Western United States. Ill. (E N-Sept. 29.) 200 w.

7037. The Okefenokee Swamp. J. L. Parr (R A-Sept. 30.) 900 w.

7055. Early Water Works (M N-Oct. 1.) 500 w.

†7063. Detecting a Waste of Water. Byron I. Cook (J N E W-Sept.) 1200 w.

†7064. Two Methods of Obtaining Fire Protection by Direct High Pressure. Geo. A. Ellis (J N E W-Sept.) 2500 w.

†7065. The Venturi Meter. Ill. R. A. Robertson, Jr. (J N E W-Sept.) 3000 w.

†7066. The Arrangement of Hydrants and Water Pipes for the Protection of a City against Fire. Ill. John R. Freeman (J N E W-Sept.) 10,000 w.

†7067. The Franklin N. H. Water Works. F. L. Fuller (J N E W-Sept.) 2500 w.

7130. Filtering Water. II. (Met W-Oct. 8.) 2000 w.

7157. Origin of the Reservoir System. Horace B. Hudson (F W-Oct. 8.) 1200 w.

*7217. Bateau de Sauvetage à Vapeur et à Propulsion Hydraulique. Ill. G. O. Ahead (G C-Sept. 17.) 1600 w.

†7296. Influx of Water into Wells. R. W. Western (I E-Sept. 10.) 1000 w.

7299. Irrigation by Artesian Wells (E N-Oct. 13.) 800 w.

*7316. Etude sur les Eaux de Cayenne. M. Goldenstein (G C-Oct. 1.) 2400 w.

INDUSTRIAL CHEMISTRY.

*6626. What Engineering Owes to Chemistry. A. L. Griswold (E Mag-Nov.) 3000 w.

*6745. The Analysis of Nitro-Explosives. P. Gerald Sanford (C T J-Sept. 10.) 2500 w.

†6759. A Peculiar Reaction of the Niagara River Water. Edward Gudeman (J A C S-Sept.) 500 w.

7074. Chemistry of Water as Applied to Technical Purposes. Arthur Pennell (P S-Oct.) 1400 w.

*7239. Procédé pour l'Epuration des Eaux d'Egout au Moyen de Ferrite Alcalin ou de Ferro Aluminate Alcalin. Carl Liesenberg (M I-Sept. 6.) 800 w.

INDUSTRIAL SOCIOLOGY.

*6625. Our Costly Geological Survey. I. A Glimpse of Its Record. E. O. Wolcott. II. Reasons for Supporting It. N. S. Shaler (E Mag-Nov.) 4000 w.

6676. The Tariff on Iron Ore. Editorial (I T R-Sept. 15.) 700 w.

6679. Labor and Science. R. W. R. (E M J-Sept. 17.) 1500 w.

6680. The Tariff on Silver Lead Ore (E M J-Sept. 17.) 3000 w.

*6688. Condition of Labor in Switzerland. Editorial (E-Sept. 9.) 1800 w.

*6701. The Export of Iron Ore from Spain and its Influence. Walter J. May (I-Sept. 9.) 700 w.

*6704. Proposed Technico-Scientific Society for the Textile Industries. B. H. Thwaite and Roberts Beaumont (I L-Sept. 9.) 2000 w.

†6725. A Possible Solution of the Social Question. C. Godfrey Gumpel (W R-Sept.) 7500 w.

†6727. Human Selfishness: Trade Disputes. Alfred Slater (W R-Sept.) 4000 w.

6815. Labor and Wages. R. W. R. (E M J-Sept. 24.) 800 w.

*6827. Labor in Austria (E-Sept. 16.) 2500 w.

†6903. The Buffalo Strike. Theodore Voorhees (N A R-Oct.) 4500 w.

†6904. The Ethics of Great Strikes. Geo. Ethelbert Walsh (N A R-Oct.) 1200 w.

6916. Labor in Switzerland. Editorial (A M-Sept. 29.) 450 w.

6921. Non-Union Mills (Ir Age-Sept. 29.) 2500 w.

6966. Labor and Legislation. R. W. R. (E M J-Oct. 1.) 2800 w.

*7054. Rights of Employers. H. F. Henry, Jr. (S Ec-Oct.) 2000 w.

7324. Labor and Organization. R. W. R. (E M J-Oct. 15.) 1500 w.

LANDSCAPE ENGINEERING.

†6855. The Formal Garden in England. H. L. W. (A Rev-June 13.) 2800 w.

MARINE ENGINEERING.

*6685. Aluminium Naphtha Yacht "Mignon" (E-Sept. 9.) 1100 w.

*6687. The New Cunarders (E-Sept. 9.) 1200 w.

6773. Our Merchant Marine. Percy W. Thompson (Am S-Sept. 22.) 500 w.

6836. Tank Steamers for Suez Canal Oil Traffic (A M & I W-Sept. 23.) 700 w.

*6842. The Inman Steamship Company and Southampton (I L-Sept. 16.) 1500 w.

*6843. Marine Propellers. Alexander Vogelsang (I L-Sept. 16.) 1200 w.

*6864. Semaphore v. Morse. Ill. (El-Sept. 16.) 1400 w.

*6870. Recent Progress in Armor Plates. Ill. (Eng L-Sept. 16.) 2500 w.

6929. Iron vs. Wood. I. Percy W. Thompson (Am S-Sept. 29.) 700 w.

6930. British Steamship America, Designed by an American (Am S-Sept. 29.) 900 w.

6944. The Marine Department of the Maryland Steel Co.—at Sparrow Point (Sea-Sept. 29.) 9000 w.

*7024. Modern Systems of Refrigeration in Ships (M W-Sept. 23.) 1800 w.

7087. Coast Defense Monitor Miantonomoh (M & B-Sept.) 700 w.

*7169. Modern Systems of Refrigeration in Ships (M W-Sept. 30.) 2200 w.

*7185. Engines and Boilers in the Navy. Editorial (Eng L-Sept. 30.) 1500 w.

*7204. La Batellerie Française. I. V. Turquan (G C-Sept. 3.) 2500 w.

*7208. La Batellerie Française. Ill. II. V. Turquan (G C-Sept. 10.) 2700 w.

*7231. Torpilleurs Sous-Marins. II. Ill. Georges Dary (El P-Sept. 10.) 2300 w.

*7246. The Treatment of Marine Boilers. W. W. Wilson (M E-Oct. 1.) 10,000 w.

*7247. Seven Years of the World's Mercantile Ship-building. Ill. (M E-Oct. 1.) 1200 w.

*7248. Description of the Lifting and Hauling Appliances in Portsmouth Dock-yard. Ill. John T. Corner (M E-Oct. 1.) 800 w.

*7249. Refrigerating Machinery (M E-Oct. 1.) 1000 w.

*7259. Stockless Anchors. Ill. (S L-Oct.) 1200 w.

*7260. Marine Propellers and Hydraulic Propulsion. Alex. Vogelsang (S L-Oct.) 2000 w.

7281. The Shipping Bounty Question in France (Ir Age-Oct. 13.) 3000 w.

7305. Maine's Ship-building Center. Ill. (Sea-Oct. 13.) 2000 w.

7308. Iron vs. Wood. II. Percy W. Thompson (Am S-Oct. 13.) 800 w.

MECHANICAL ENGINEERING.

*6623. Progress in the Art of Wood-Working. C. R. Tompkins (E Mag-Nov.) 3000 w.

6663. Double Endless Bed Surfacer. Ill. (M R-Sept. 16.) 1200 w.

*6714. Different Lubricants and When to Use Them. B. Verniaud (Inv–Sept. 10.) 1000 w.

*6757. Water Power. IV. Ill. E. Tremlett Carter (E R L–Sept. 9.) 2500 w.

6768. Practical Details of Die-sinking. II. B. F. Spalding (A M–Sept. 22.) 2200 w.

6770. Cogging Wheels. IV. Ill. Joseph Horner (A M–Sept. 22.) 900 w.

6798. Metal-Cutting Tools. III. (Ir Age–Sept. 22.) 2800 w.

6894. Emery Wheels. C. R. Tompkins (A S–Sept. 24.) 1200 w.

*6896. Power Transmission by Ropes (E R L–Sept. 16.) 1500 w.

*6901. Water Power. V. Ill. E. Tremlett Carter (E R L–Sept. 16.) 4000 w.

6914. Pouring, Flowing-off, and Feeding Castings. I. Ill. S. Bolland (A M–Sept. 29.) 3500 w.

6917. The Manufacture of Seamless Steel Tubes. Ill. (Ir Age–Sept. 29.) 1200 w.

6919. Metal-Cutting Tools. IV. (Ir Age–Sept. 29.) 4500 w.

*7017. Water-Power. VI. Ill. E. Tremlett Carter (E R L–Sept. 23.) 2200 w.

7084. Metal-Cutting Tools. V. (Ir Age–Oct. 6.) 4500 w.

7095. Rubber Pattern Work. Ill. John T. Usher (A M–Oct. 6.) 3000 w.

7096. Cogging Wheels. V. Joseph Horner (A M–Oct. 6.) 1500 w.

7133. The Principles of Ice-Making, with Descriptions of Machines in Use, and an Article by E. C. Hillyer on "How to Make an Ice Factory Pay." Ill. (M R–Oct. 7.) 15,000 w.

*7184. Toothed Gearing for Large Powers. Editorial (Eng L–Sept. 30.) 1500 w.

*7219. Les Installations Mécaniques du Panorama "Le Vengeur." Ill. G. Richou (G C–Sept. 24.) 1000 w.

*7242. Sur les Machines Frigorifiques à Air et leur Application à la Congélation des Viandes. M. de Marchena (M I–Sept. 13.) 3000 w.

*7253. Water Power. VII. Ill. E. Tremlett Carter (E R L–Sept. 30.) 3000 w.

*7266. The "Triumph" Chain-Making Machine. Ill. (E–Sept. 30.) 3500 w.

7282. Metal-Cutting Tools. VI. (Ir Age–Oct. 13.) 3000 w.

7285. Exhibition and Description of Combined Yard and Meter Standard Bar. Wm. A. Rogers (A M–Oct. 13.) 700 w.

7287. Pouring, Flowing-off, and Feeding Castings. II. Ill. S. Bolland (A M–Oct. 13.) 1700 w.

7327. The Stein Vanner. Ill. John W. Meier (E M J–Oct. 15.) 1000 w.

7336. Peculiar Crank Effects. Ill. Albert D. Pentz (M R–Oct. 14.) 2000 w.

METALLURGY.

6645. Important Innovations in Open Hearth and Bessemer Practice. Ill. (E N–Sept. 15.) 1700 w.

6681. The Treatment of Argentiferous Zinc-Lead Sulphids. I. C. Schuabel (E M J–Sept. 17.) 1600 w.

*6700. The Extraction of Magnetic Particles from Auriferous and other Ores. Walter B. Bassett (I–Sept. 9.) 900 w.

*6702. Wolfram-Ore (I–Sept. 9.) 1400 w.

*6746. Processes for the Extraction of Aluminium from 1886 to 1890. H. N. Warren (C T J–Sept. 10.) 900 w.

6765. Electro-Metallurgy. XIV. Ill. F. M. F. Cazin (E W–Sept. 24.) 2800 w.

6803. The Treatment of Argentiferous Zinc-Lead Sulphids. II. C. Schuabel (E M J–Sept. 24.) 3500 w.

*6823. The Works of the Schulz-Knaudt Company, Limited. Ill. (E–Sept. 16.) 1200 w.

*6839. The Steel Production in Great Britain in 1892 (C G–Sept. 16.) 500 w.

*6846. The International Iron and Steel Standards (I L–Sept. 16.) 2000 w.

6853. American Tin Plates (A A–Sept. 24.) 4800 w.

*6862. Calculations of Charge for the Lead Blast Furnace (I–Sept. 16.) 2000 w.

*6902. Electro-Metallurgy. J. Wilson Swan (N–Sept. 15.) 5500 w.

6908. Electro-Metallurgy. XV. Ill. F. M. F. Cazin (E W–Oct. 1.) 2000 w.

6912. The Cyanide Process. Prof. Morton (M S P–Sept. 24.) 2000 w.

6967. The Non-Homogeneity of Certain Gold Bars. Louis Janin, Jr. (E M J–Oct. 1.) 400 w.

*6999. Alloys of Iron and Chromium. R. A. Hadfield (E–Sept. 23) 4000 w.

*7004. President's Address at the Liverpool Meeting of the Iron and Steel Institute (I–Sept. 23.) 1800 w.

*7005. The Manufacture of Iron in its Relations with Agriculture. I. Lowthian Bell (I–Sept. 23.) 8000 w.

*7006. An Appliance for Autographically Recording the Temperature of Furnaces. Prof. Roberts Austin (I–Sept. 23.) 2500 w.

*7008. Failures in the Necks of Chilled-Iron Rolls. Chas. A. Winder (I–Sept. 23.) 5000 w.

*7012. Granulating Iron and Other Ores for Concentration. Walter J. May (C G–Sept. 23.) 1500 w.

*7013. The Manufacture and Casting of Steel in the Crucible. M. E. Deny (C G–Sept. 23.) 1400 w.

7028. Forty Years Progress in Steel Castings. M. L. Campredon (A G L J–Oct. 3.) 1000 w.

7071. Electro-Metallurgy. XVI. Ill. F. M. F. Cazin (E W–Oct. 8.) 900 w.

7088. Aluminum Solder (M & B–Sept.) 800 w.

7092. Alloys of Iron or Steel and Nickel (Sc A–Oct. 8.) 2000 w.

7151. The Cyanide Process in South Africa.

I. Chas. Butters and John Edw. Clennell (E M J–Oct. 8.) 2500 w.

7163. Origin of Placer Gold. Editorial (M I T–Oct. 6.) 1000 w.

*7168. The Fuel of the Blast Furnace. Vaughan Cornish (K–Oct. 1.) 1500 w.

*7191. Some Alloys of Iron, Aluminium, and Manganese. T. W. Hogg (I–Sept. 30.) 1000 w.

7200. The Pyrites Industry. Editorial (A S–Oct. 8.) 500 w.

*7238. Note sur l'Existence, dans les Terres, d'une Matière Minérale Acide Encore Indeterminée. Paul de Mondesir (M I–Sept. 6.) 900 w.

*7240. Les Briques Réfractaires dans les Hauts Fourneaux. F. W. Lurmann (M I–Sept. 13.) 1600 w.

†7245. Le Silicium et l'Aluminium dans la Métallurgie de l'Acier. Sergius Kern (R U M–Aug.) 2000 w.

7250. The Purification of Iron and Steel from Sulphur. E. H. Saniter (A S–Oct. 8.) 1200 w.

*7258. The Manufacture of Soft Steel for Castings. M. E. Deny (C G–Sept. 30.) 1500 w.

7277. Electro-Metallurgy. XVII. F. M. F. Cazin (E W–Oct. 15.) 2500 w.

7283. The Shenango Valley Bessemer Plant. Ill. (Ir Age–Oct. 13.) 800 w.

7307. The Cyanide Process—Remarks on the Discussion of its Novelty. C. H. Aaron (M S P–Oct. 8.) 1000 w.

*7318. Expériences Pratiquées par M. H. Moreillon pour Etudier les Transformations Moléculaires dans le Fer. Ill. L. Baclé (G C–Oct. 1.) 2200 w.

7325. The Elimination of Sulphur from Iron. J. E. Stead (E M J–Oct. 15.) 1200 w.

7326. The Cyanide Process in South Africa. II. Ill. Chas. Butters and John Edw. Clennell (E M J–Oct. 15.) 2000 w.

7335. Iron Ore Product of the South in 1891 (M R–Oct. 14.) 1400 w.

MILITARY ENGINEERING.

6666. Riot Duty of the Pennsylvania Guard. Wm. J. Volkmar (A & N J–Sept. 17.) 6000 w.

*6684. Modern United States Artillery. XXIV. (E–Sept. 9.) 2000 w.

*6713. Night Sights. (Eng L–Sept. 9.) 1000 w.

*6822. Schneider and Co.'s 15-Centimeter (5.9 in.) Quick-Firing Gun. Ill. (E–Sept. 16.) 3500 w.

6832. The Krag-Jorgensen Rifle. (B J C–Sept. 24.) 300 w.

*6852. Improvements in the Science of Warfare. Charles E. Monroe (Ch–Oct.) 3500 w.

*6994. Modern United States Artillery. XXV. Ill. (E–Sept. 23.) 3000 w.

†7039. Electricity and the Art of War. C. D. Parkhurst (J U S A–Oct.) 17,000 w.

†7040. Recoil of Heavy Guns and its Control. Henry C. Davis (J U S A–Oct.) 11,000 w.

†7041. Demolition of Concrete Gun Platforms and Magazines at Fort Monroe, Virginia, 1892. Geo. A. Zinn (J U S A–Oct.) 1600 w.

†7042. The Time Fuse with Shrapnel Fire. A. D. Schenck (J U S A–Oct.) 5000 w.

†7058. Fiske's Electrical Range Finder (J F I–Oct.) 2500 w.

*7109. Torpedo Ethics (I S F–Oct.) 900 w.

*7203. Etude Comparative du Matériel des Canons a Tir Rapide. G. T. (G C–Sept. 3.) 7500 w.

*7210 Utilisation de la Charrue en Temps de Guerre. F. Chaudy (G C–Sept. 10.) 1200 w.

*7221. Notre Artillerie de Campagne. Aristide Fauconneau (G C–Sept. 24.) 4200 w.

*7241. Les Nouveaux Mortiers de la Guerre et leur Utilisation sur la Flotte. M. Chabaud-Arnault (M I–Sept. 13.) 1100 w.

*7261. Modern United States Artillery. XXVI. Ill. (E–Sept. 30.) 2200 w.

*7264. Quick-Firing Guns (E–Sept. 30.) 3000 w.

MINING.

6659. The Mines of Plumas County. Chas. E. Townsend (M S P–Sept. 10.) 3300 w.

6660. Florida Phosphates: Future Prospects. C. C. Hoyer Millar (M R–Sept. 16.) 1000 w.

6662. Pocahontas Flat-Top Field. II. (M R–Sept. 16.) 2000 w.

*6675. The Mining Industries of Huelva. (C T J–Aug. 13.) 500 w.

6677. An Improved Coal Washer. S. Stutz (I T R–Sept. 15.) 1000 w.

6683. The Canadian Asbestos Industry (E M J–Sept. 17) 1200 w.

*6691. The Countermining of Belfast Lough (E–Sept. 9.) 2000 w.

*6699. Metalliferous Mining in New Zealand. Geo. J. Binns (I–Sept. 9.) 4800 w.

*6710. Influence of Coal Dust on Explosives in Mines. Editorial (P Eng–Sept. 9.) 800 w.

*6736. Losses in Bulk in Ore Concentration Gauges. Walter J. May (C G–Sept. 9.) 1200 w.

*6737. Underground Hauling by Electric Locomotives. Clément Baily (C G–Sept. 9.) 1500 w.

*6738. Influence of the Form and Arrangement of Mine Workings on the Effects of Fire-damp Explosions. Ill. M. Raveaud (C G–Sept. 9.) 3500 w.

*6739. On the Method of Opening Out the Rearer Coals of North Staffordshire. Ernest Craig (C G–Sept. 9.) 1000 w.

*6744. The Phosphates of Algeria and Tunis (C T J–Sept. 10.) 500 w.

†6758. Some New Nickel Minerals. Stephen H. Emmens (J A C S–Sept.) 1800 w.

6804. Determination of the Efficiency of Coal. I. H. Bunte (E M J–Sept. 24.) 1000 w.

6806. Zinc in Arkansas. Macbeth Young (M R–Sept. 23.) 1000 w.

6807. South American Coal Trade. O. G. H. E. Kehrkahn (M R–Sept. 23.) 1200 w.

6816. Mineral Zones in Montana. H. R. Wood (E M J–Sept. 24.) 1000 w.

6817. Butte City, Montana. Ill. S. E. Raunheim (E M J–Sept. 24.) 1500 w.

6818. The Rats of the "Lower Levels." Dan de Quille (E M J–Sept. 24.) 1200 w.

*6838. Nature and Production of Firedamp. H. Le Châtelièr (C G–Sept. 16.) 2200 w.

6847. The World's Consumption of Coal (M & El–Sept. 21.) 300 w.

6948. The General Electric Company's Mining Locomotive. Ill. (W E–Oct. 1.) 500 w.

6951. Byrd Coal Mine, Harriman, Tenn. Ill. Louis E. Bryant (M R–Sept. 30.) 1800 w.

6968. The Iron Ore Mines of the Sloss Iron and Steel Company, Alabama. Ill. (E M J–Oct. 1.) 1000 w.

6969. Eschka's Method of Determining Sulphur in Coal. F. Hundeshagen (E M J–Oct. 1.) 450 w.

6970. Mining in the Pyrenees. A. G. Charleton (E M J–Oct. 1.) 2000 w.

6981. Coal Mines of Vancouver Island (A M & I W–Sept. 30.) 500 w.

6985. Coal Mining Machinery (T–Oct. 1.) 800 w.

*7011. Disengagement and Accumulation of Fire Damp, with Observations on Barometric Influence. H. Le Châtelier (C G–Sept. 23.) 4000 w.

7075. Asphaltum Deposits in South America (M S R–Sept. 29.) 400 w.

7076. Peru's Petroleum Possibilities (M S R–Sept. 29.) 400 w.

7093. Taxation of Mines in Mexico (M S P–Oct. 1.) 3800 w.

7144. Coal Mining in North Staffordshire. A. A. Atkinson (C E–Oct.) 3200 w.

7145. A National Commission on Accidents in Mines (C E–Oct.) 5000 w.

7146. An Automatic Culm or Slack Conveyor (C E–Oct.) 800 w.

7147. The Practical Working of Coal-Cutting Machines. Richard Sutcliffe (C E–Oct.) 3000 w.

7150. The Barrier Range Silver Field, Australia. G. E. Boxall (E M J–Oct. 8.) 2000 w.

7153. Mining in the Donetz Coalfields, Russia (E M J–Oct. 8.) 1600 w.

*7192. Coal and Iron in Chili (I–Sept. 30.) 700 w.

*7211. Les Gisements de Platine de la Russie (G C–Sept. 10.) 1000 w.

*7213. Les Mines de la Nouvelle Calédonie. I. Louis Pelatan (G C–Sept. 17.) 1600 w.

*7220. Les Mines de la Nouvelle Calédonie. III. II. Louis Pelatan (G Ç–Sept. 24.) 4400 w.

†7243. Préparation Mécanique des Minerais. Ill. Aug. Gillon (R U M–Aug.) 1900 w.

†7244. Le Matériel des Mines. IX. Extraction. Ill. A. Habets (R U M–Aug.) 8800 w.

*7255. Coal Washing by the Luhrig Process. Walter J. May (C G–Sept. 30.) 2500 w.

*7256. The Nong Sou Coal Beds, Tonkin. P. de Bure (C G–Sept. 30.) 1000 w.

*7257. Phosphate Chemistry as it Concerns the Miner. Thomas M. Chatard (C G–Sept. 30.) 6500 w.

*7317. Les Mines de la Nouvelle Calédonie. III. Ill. Louis Pelatan (G C–Oct. 1.) 5000 w.

7328. The Transvaal Silver Mines (E M J–Oct. 15.) 900 w.

RAILROADING.

*6629. The Electric Motor and the Farmer. Wm. Nelson Black (E Mag–Nov.) 3000 w.

6641. On the Prospect of Storage Batteries for Electric Traction. Gautherot (E E N Y–Sept. 14.) 2000 w.

6652. Baldwin Locomotive and Railway Improvements in New South Wales. C. V. R. (E N–Sept. 15.) 800 w.

6657. A New Automatic Slack Adjuster for Air Brakes. Ill. (E N–Sept. 15.) 800 w.

6658. Protection of Railway Tracks Against Torrents and Earth Slides in Sicily, Italy. Ill. (E N–Sept. 15.) 800 w.

6667. Variations in Braking Power Resulting from Different Brake Shoe Metals. Paul Synnestvedt (R G–Sept. 16.) 1700 w.

6668. Air Brake Trials (R G–Sept. 16.) 1200 w.

6669. The Dean Compound (R G–Sept. 16.) 1200 w.

6670. A Swiss Street Rack Railroad. Ill. (R G–Sept. 16.) 1500 w.

6671. The Transandine Railroad (R G–Sept. 16.) 700 w.

6672. Cost of Renewals of Cross Ties (R G–Sept. 16.) 700 w.

6673. The New South Wales Engines Again (R G–Sept. 16.) 1000 w.

6674. Notes on Railroad Location and Construction in Eastern Canada. Wm. B. Mackenzie (R G–Sept. 16.) 1000 w.

*6686. Russian Compound Locomotive (E–Sept. 9.) 700 w.

*6689. The Brain System of Electric Tramways (E–Sept. 9.) 1000 w.

6697. Are Improved Methods Necessary for the Handling of Suburban Traffic? Sub Urban (R A–Sept. 16.) 500 w.

*6708. Electrical Traction on Tramways.—The Brain System. Ill. (E E L–Sept. 9.) 2000 w.

6711. Railroad Motive Power. I. (S M–Sept. 15) 1000 w.

*6740. The Position and Prospects of the Rail Trade (C G–Sept. 9.) 1400 w.

6751. Air Brake Trials on the New York Central & Hudson River Railway (R R–Sept. 17.) 600 w.

6753. The Effect of Illegitimate Circuitous Routes (R R–Sept. 17.) 1600 w.

6775. On the Conditions and Requirements of a Practical Conduit Trolley System. I. R. J. Hewitt (E E N Y–Sept. 21.) 1300 w.

6777. The Comparative Efficiency of the Commutated Field and the External Resistance Controlling Railway Switches. Thorburn Reid (E E N Y–Sept. 21.) 1800 w.

6785. American Locomotives for New South Wales. Ill. (E N–Sept. 22.) 600 w.

6789. The Purdue University Locomotive on Grades. Ill. (E N–Sept. 22.) 1500 w.

6793. A New Design for High Speed Cars. Ill. (S R R–Sept.) 500 w.

6794. The Rapid Transit Systems of Cleveland. Ill. (S R R–Sept.) 6000 w.

6795. Cleveland Manufacturers of Street Railway Supplies. Ill. (S R R–Sept.) 4500 w.

6801. Notes on British Train Speeds. IV. (R G–Sept. 23.) 800 w.

6809. The Problem of Stopping from Ninety Miles an Hour. Geo. Westinghouse, Jr. (R G–Sept. 23.) 900 w.

6811. Railroad Sanitation in Time of Cholera. Samuel W. Latta (R G–Sept. 23.) 2500 w.

6812. The Construction and Working of the State Railroads of Bosnia and Herzegovina. F. Pfeuffer (R G–Sept. 23.) 1200 w.

6813. Provident Funds on Indian Railroads (R G–Sept. 23.) 2500 w.

*6821. The Interoceanic Railways of Central America. Ill. (E–Sept. 16.) 2000 w.

*6825. The New South Wales Railways. Editorial. (E–Sept. 16.) 3500 w.

*6829. Renewing Railway Viaducts in Scotland. Ill. (E–Sept. 16.) 4000 w.

*6840. An Experimental Locomotive. Ill. W. F. M. Goss (I L–Sept. 16.) 3000 w.

*6841. The Irish Light Railways. Ill. (I L–Sept. 16.) 1200 w.

6878. The New York Central Air Brake Tests. Ill. (R R–Sept. 24.) 1000 w.

6879. Steam Car Heating. J. C. Halladay (R R–Sept. 24.) 1500 w.

6881. Wagner Car Framing. Ill. (R R–Sept. 24.) 300 w.

6882. The Proper Status of the Rate-Making Power. Editorial (R R–Sept. 24.) 900 w.

6883. Protection of Bills of Lading (R R–Sept. 24.) 1200 w.

6884. The Formosan Government Railway. Henry Chipps Matheson (R R–Sept. 24.) 2000 w.

6885. Double Track Bridge of the Chicago Elevated Road. Ill. (R A–Sept. 23.) 200 w.

6886. The Position and Duties of the Train Dispatcher (R A–Sept. 23.) 3000 w.

*6905. The Great Railway Systems of the United States. Ill. (Cos–Oct.) 5000 w.

6909. Report of Committee on Recent Improvements in Electric Traction (E R N Y–Oct. 1.) 2000 w.

6918. Wire Rope Tramways. Ill. (Ir Age–Sept. 29.) 600 w.

6937. Automatic Stopping Devices for Block Systems (E N–Sept. 29.) 1200 w.

6938. A Policy for the Application of Air Brakes and Automatic Couplers. Edward B. Wall (E N–Sept. 29.) 2000 w.

6945. Armour's Elevated Electric Road. Ill. (W E–Oct. 1.) 400 w.

6959. "Per Diem" Once More. S. B. S. (R G–Sept. 30.) 1000 w.

6961. How to Meet Safety Appliance Legislation. Edward B. Wall (R G–Sept. 30.) 1400 w.

6962. Car Heating by Steam. A. M. Waitt (R G–Sept. 30.) 2300 w.

*6974. The Underground Railroad of London—A Comparison. Ill. John A. Hill (L E–Oct.) 2500 w.

*6975. Railroad Blacksmithing. W. G. Lottes (L E–Oct.) 1500 w.

*6977. Taking Care of Driver-Brakes. Paul Synnestvedt (L E–Oct.) 1000 w.

*6978. Emergency and Service Application of Brakes. George Holmes (L E–Oct.) 1400 w.

*6979. Train Running for the Confederacy. Carter S. Anderson (L E–Oct.) 4500 w.

6987. The Proposed Labrador Railway (M & El–Sept. 28.) 350 w.

†6989. Electricity and the Cable in Great Britain. Alex. McCallum (S R J–Oct.) 3500 w.

†6990. The Power Stations of the Brooklyn City Railway. Ill. (S R J–Oct.) 1200 w.

†6991. Rail Sections and Special Construction. Geo. W. Mansfield (S R J–Oct.) 2000 w.

*6997. The Resistance of Railway Curves. Editorial (E–Sept. 23.) 1800 w.

*7007. The Liverpool Overhead Railway J. H. Greathead (I–Sept. 23.) 2000 w.

7019. Causes and Remedies for Shocks at Rail Joints. Joseph Anthony (R M M–Oct.) 900 w.

7020. Economy in Fuel. S. P. Eush, M. S. Connors, C. B. Legar (R M M–Oct.) 1000 w.

*7021. Baldwin Locomotives in New South Wales (Eng L–Sept. 23.) 5600 w.

7029. Why Rails Creep. Jerry Sullivan (R R–Oct. 1.) 800 w.

7030. The Scope of Railway Regulation. Editorial (R R–Oct. 1.) 1000 w.

7031. Who Are Fellow-Servants. Editorial (R R–Oct. 1.) 1400 w.

7036. The Wages of Railway Employés Editorial (R A–Sept. 30) 800 w.

7038. Some Cars for Indian Princes (R A–Sept. 30.) 500 w.

*7044. The Wheel Record. J. N. Barr (J A E S–Aug.) 5000 w.

*7049. The Transition Curve. W. H. Echols (R A E J–Oct.) 2500 w.

*7050. Crossings of Great Rivers. Ill. A. Zdziarski (R A E J–Oct.) 2500 w.

*7057. The Electrical Installations of the Railway across the Andes. Ill. (E L–Sept. 23.) 1000 w.

7080. A Practical Conduit Trolley System. Ill. R. J. Hewett (E E N Y–Oct. 5.) 1200 w.

7081. On the Prospect of Storage Batteries

for Electric Traction. G. Herbert Condict (E E N Y-Oct. 5.) 600 w.

7089. Burgett Park. Ill. (E N Y-Oct. 5.) 2000 w.

7111. An Economical System of Handling Earth. Ill. (E N-Oct. 6.) 1000 w.

7115. The Early Pile Railways (E N-Oct. 6.) 1500 w.

7124. "One Cent per Diem"—A Letter from the Author of the Plan. S. H. Church (R G-Oct. 7.) 1000 w.

7125. Wire Rope Transportation and Transmission (R G-Oct. 7.) 2800 w.

7126. The Six Old Chicago Railroads. I. (R G-Oct. 7.) 1500 w.

7127. Uniformity in Block and Interlocking Signal Systems (R G-Oct. 7.) 1200 w.

7128. The Abolition of Grade Crossings. Augustus W. Locke (R G-Oct. 7.) 1000 w.

7129. La Guaira and Caracas Railroad. Edwin Harry Alfred Heinké (R G-Oct. 7.) 1200 w.

7138. Ratchet Railway and Elevator of Notre Dame La Garde at Marseilles (S R G-Oct. 3.) 700 w.

7139. Quick Time Made by an American Engine in New Zealand. Ill. (R A-Oct. 7.) 500 w.

*7158. The Grand Trunk Railway of Canada. Ill. (R W-Oct.) 1500 w.

*7159. The Ballasting of Railroads. Ill. (R W-Oct.) 900 w.

*7160. The Black Pool Electric Tramway. Ill. (R W-Oct.) 1400 w.

*7161. The Leicester and Swannington Railway. Ill. (R W-Oct.) 2000 w.

*7182. Peninsular and Oriental Express Dining Cars. Ill. (Eng L-Sept. 30.) 500 w.

*7183. The Subsidence on the Furness Railway. Ill. (Eng L-Sept. 30.) 700 w.

*7190. Electric Traction in Paris (E E L-Sept. 30.) 500 w.

7195. Unity of Railways and Railway Interests. Aug. Schoenmaker (R R-Oct. 8.) 3500 w.

7196. Insuring the Maintenance of Rates. Aldace F. Walker (R R-Oct. 8.) 1500 w.

7197. Responsibilities of Bridge Foremen. Quinton McNab (R R-Oct. 8.) 700 w.

7198. The Rights and Duties of Connecting Railway Lines. Editorial (R R-Oct. 8.) 1400 w.

7199. The Relations of Rolling Stock to Track. Hugh Baines (R R-Oct. 8.) 2000 w.

*7205. Démarrage des Tramways et Autres Véhicules: Procédé Quincy. Ill. F. Desquiens (G C-Sept. 10.) 1000 w.

*7237. Les Moteurs Electriques pour Tramways. Ill. Em. Dieudonné (El P-Sept. 24.) 2700 w.

*7263. The Metre v. Standard Gages in India (E-Sept. 30.) 2000 w.

*7265. New Terminal Railway Station at Edinburgh. Ill. (E-Sept. 30.) 2700 w.

*7272. Progress in Electric Railway Building (E I-Oct.) 600 w.

*7273. Overhead Construction for Electric Railways. Ill. (E I-Oct.) 3000 w.

7284. The McLeod System of Railroad Car Heating and Ventilating. Ill. (R C J-Oct.) 1800 w.

†7295. Proposed Railway Routes on the West Coast of Southern India. Ill. (I E-Sept. 10.) 350 w.

7298. Statistics Showing the Progress and Prospects of Railway Construction in the Southwestern States. Ill. (E N-Oct. 13.) 1500 w.

7300. The Price Rail Joints. Ill. (E N-Oct. 13.) 600 w.

7302. The Cause of Cracked Plates in Cast Iron Car Wheels. Ill. (E N-Oct. 13.) 4000 w.

7304. Standard Rules for the Movement of Trains under the Block System (E N-Oct. 13.) 3500 w.

7313. The New Station of the Lowell and Suburban Street Railway Company, Lowell, Mass. Ill. A. C. Shaw (E E N Y-Oct. 12.) 2200 w.

7314. Test of a Sprague No. 6 Street Car Motor. Ill. Cary T. Hutchinson (E E N Y-Oct. 12.) 500 w.

7340. Central Station at Twelfth Street, Chicago, Illinois Central Railroad. Ill. (R G-Oct. 14.) 1800 w.

7342. Uniform Practice with Fixed Signals (R G-Oct. 14.) 2500 w.

7443. A Method of Protecting Drawbridges. C. A. Hammond (R G-Oct. 14.) 1700 w.

7344. Rail Joints (R G-Oct. 14.) 4500 w.

7345. Fares to New York during the World's Fair (R G-Oct. 14.) 900 w.

7346. The Six Old Chicago Railroads. II. (R G-Oct. 14.) 2500 w.

7347. Continuous Indicators. W. H. Booth (R G-Oct. 14.) 3300 w.

SANITARY ENGINEERING.

6644. Review of an Index to the Literature Relating to the Disposal of Town Refuse. Wolcott C. Foster (P-Sept.) 3500 w.

6655. The Joints of American Vitrified Sewer Pipe. Ill. Malverd A. Howe (E N-Sept. 15.) 1000 w.

*6692. Portsmouth Sewage Outfall Works. Ill. Sir Frederick Bramwell (E-Sept. 9.) 4800 w.

†6760. Note on the Direct Oxidation of Organic Matter in Water. W. P. Mason and S. K. Hine (J A C S-Sept.) 700 w.

6762. The Sterilization of Infected and Other Sewage by Means of Electricity. Bleyer (E R N Y-Sept. 24.) 800 w.

6767. Drainage and Water Supply. John Mabbs (S E-Sept. 17.) 3500 w.

6792. Sewage Purification in America. VIII. (E N-Sept. 22.) 2000 w.

*6830. The Disposal of Refuse. G. Watson (E-Sept. 16.) 2800 w.

6935. Cholera as a Sanitary Agent. Editorial (E N-Sept. 29.) 2000 w.

6940. Sewage Purification in America. IX. Ill. (E N-Sept. 29.) 1000 w.

*6998. Sewage Precipitation Works. Ill. Wm. B. G. Bennett (E-Sept. 23.) 3000 w.

7094. The Right Way to Dispose of the City's Refuse (Am S-Oct. 6.) 1200 w.

7110. Sewage Purification in America. X. Ill. (E N-Oct. 6.) 2500 w.

7113. City Refuse Disposal. Editorial (E N-Oct. 6.) 900 w.

*7116. Typhoid Fever—Its Prevention and Restriction (A H-Oct.) 1400 w.

7137. The Victorian Era, the Age of Sanitation. Chas. Cameron (A & B-Oct. 8.) 2500 w.

7141. The Manufacture of Vitrified Sewer Pipe (A G L J-Oct. 10.) 1200 w.

*7193. The Beginning of the End. Editorial (C T J-Oct. 1.) 1000 w.

7194. Warming and Ventilation of Dwellings. Ill. (A Ar-Oct. 8.) 1800 w.

7206. L'Assainissement de la Ville de Rouen. Gérard Lavergne (G C-Sept. 10.) 2000 w.

*7214. De l'Organisation, dans une Usine, des Premiers Secours en Cas d'Accidents. Ill. Henri Mamy (G C-Sept. 17.) 2300 w.

*7215. Utilisation des Ordures Menagères des Villes par Voie de Combustion. Max de Nansouty (G C-Sept. 17.) 1400 w.

*7262. Sanitation at Manchester. Editorial (E-Sept. 30.) 2800 w.

*7293. The Pollution and Purification of Rivers. H. A. Roechling (J G L-Oct. 4.) 3000 w.

7297. Sewage Purification in America. XI. Ill. (E N-Oct. 13.) 1200 w.

STEAM ENGINEERING.

6693. Testing Boilers, Paris, Texas (B J C-Sept. 17.) 1500 w.

6694. Old Time Marine Boilers. I. G. Marion White (Eng-Sept. 17.) 1000 w.

6695. Franklin's Experiments with the Smoke Nuisance. Ill. (A Ar-Sept. 17.) 1000 w.

6723. More Boiler Defects. Stephen Christie (S V-Sept. 15.) 800 w.

*6729. The Construction and Efficiency of Boilers of Locomotive Engines. I. Ill. (M W-Sept. 9.) 1500 w.

6735. Dissolving Smoke from Fires (P A-Sept. 15.) 800 w.

6742. The Steam Engine Indicator (M N-Sept. 15.) 1300 w.

6766. Some Causes of Heavy Pounding. A. Lever (S E-Sept. 17.) 1200 w.

6796. The Strong Vertical Triple-Expansion Engine. Ill. (Ir Age-Sept. 22.) 600 w.

6833. Economizer Explosions (B J C-Sept. 24.) 1000 w.

*6887. The Construction and Efficiency of Boilers of Locomotive Engines. II. Ill. (M W-Sept. 16.) 600 w.

*6888. Methods for the Prevention of Smoke (M W-Sept. 16.) 1500 w.

6913. Steam on the Highway (M S P-Sept. 24.) 500 w.

6915. Steam Distribution in the Corliss Engine—Large vs. Small Driving Wheels. W. E. Crane (A M-Sept. 29.) 1000 w.

6922. Calorimetric Tests of Boiler Furnaces. F. T. Roth (S E-Sept. 24.) 1200 w.

6934. Boiler Scale and Purification of Feed Water. F. A. Stinard (E N-Sept. 29.) 1000 w.

6971. Temperature of Boiler Furnaces (B J C-Oct. 1.) 1200 w.

6972. Old Time Marine Boilers. II. G. Marion White (Eng-Oct. 1.) 1300 w.

*6976. A Defense of Crucible Steel for Boiler Purposes. Edwin S. Jackman (L E-Oct.) 1000 w.

6980. Steam Domes and Feed-water Pipes. W. H. Wakeman (N M-Sept.) 1500 w.

*7025. The Construction and Efficiency of Boilers of Locomotive Engines. III. Ill. (M W-Sept. 23.) 700 w.

*7051. Steam Generators Specially Adapted for High Pressure. Ill. B. H. Thwaite (I L-Sept. 23.) 2500 w.

†7059. Economics of Automatic Engines. Ill. R. W. Thurston (J F I-Oct.) 2000 w.

7073. German Feed Water Heaters and Surface Condensers. Ill. R. O. Heinrich (P S-Oct.) 800 w.

7085. The Pacific Rolling Mill Company's Corliss Engine. Ill. (Ir Age-Oct. 6.) 800 w.

*7107. Corliss Engines. Ill. J. B. Pitchford (I S F-Oct.) 300 w.

*7170. Construction and Efficiency of Locomotive Boilers. J. D. T. (M W-Sept. 30.) 500 w.

*7176. Steam Generators Specially Adapted for High Pressures. Ill. B. H. Thwaite (I L-Sept. 30.) 1700 w.

*7207. Appareils à Gradins pour Récupérer l'Eau de Refroidissement des Condenseurs de Machines à Vapeur. Ill. T. C. H. (G C-Sept. 10.) 3100 w.

*7270. Steam Engines for Electric Light and Railway Service. II. Ill. (E I-Oct.) 800 w.

7280. The Loss of Heat from Uncovered Steam Pipes (E M-Oct.) 2000 w.

7288. Fixing the Value of Cylinder Lubricators. J. W. Matthews (S E-Oct. 8.) 800 w.

7289. Another Peculiar Accident. Ill. D. H. Welch (S E-Oct. 8.) 1500 w.

TELEPHONY AND TELEGRAPHY.

*6718. Notes on Submarine Cable Work. Ill. H. D. Wilkinson (El-Sept. 9.) 1200 w.

6778. Connecting Several Telephone Stations by a Single Line with an Exchange Office. Ill. Ed. Zetsche (E E N Y-Sept. 21.) 1200 w.

6779. Calculation of Weight of Copper Wire for Long-distance Transmission. W. F. Hasson (E E N Y-Sept. 21.) 200 w.

*6899. A Contribution to the Theory of the Telephone. Ill. (E R L-Sept. 16.) 1000 w.

*7001. Notes on Submarine Cable Work. Ill. H. D. Wilkinson (El-Sept. 23.) 1000 w.

*7251. The Lushai Field Telegraphs, 1889-90 (E R L-Sept. 30.) 1500 w.

†7330. Chemical Analysis of the Gutta-Percha Used as a Dielectric in Electric Cables. Ill. J. A. Montpellier (I R W-Oct. 15.) 1500 w.

†7331. Waxes, Gums, and Resins Used in Insulating Wires. I. Frederic A. C. Perrine (I R W-Oct. 15.) 1200 w.

MISCELLANEOUS.

*6622. Industrial Development of the South II. From Prosperity to Poverty. R. H. Edmonds (E Mag-Nov.) 3000 w.

*6630. Business Opportunities in Cuba. Ill. Eduardo J. Chibas (E Mag-Nov.) 3000 w.

6654. The Engineering Schools of the United States. XXII. (E N-Sept. 15.) 1200 w.

6661. Handling Cinder by Steam Shovel. Ill. (M R-Sept. 16.) 900 w.

6678. Coking in the Flat Top Region (A M & I W-Sept. 16.) 1000 w.

†6724. A Zollverein of the British Dominions. Julius Vogel (N C-Sept.) 4500 w.

†6726. The Present Position of Canada. Lawrence Irwell (W R-Sept.) 3500 w.

6769. The Utilization of the Power of Ocean Waves (A M-Sept. 22.) 2000 w.

6784. A Revolution in Carriages.—Traction Vehicle with Elastic Suspension. Ill. (S R G-Sept. 19.) 800 w.

6786. The Engineering Schools of the United States. XXIII. (E N-Sept. 22.) 2100 w.

6788. Reorganization of the Lawrence Scientific School (E N-Sept. 22.) 2500 w.

6814. The Ocean Transportation of Petroleum (R G-Sept. 23.) 1100 w.

6834. Short History of Lake Navigation. I. C. H. Keep (M R C-Sept. 22.) 700 w.

6835. Canada's Claim on the St. Clair Canal (M R C-Sept. 22.) 700 w.

†6848. The McKinley Act and the Cost of Living. N. W. Aldrich (F-Oct.) 5000 w.

†6849. The Republican Policy of Reciprocity. Wm. L. Wilson (F-Oct.) 4000 w.

†6857. The Chicago Manual Training School (I A-Sept.) 1200 w.

6891. Registering Manometers for the Pressure of Gas, Steam, Water, and other Fluids. Ill. M. F. Marchal (A G L J-Sept. 26.) 1200 w.

6911. Utilizing Waste Products of Petroleum Distillation (M S P-Sept. 24.) 500 w.

6920. The Manufacture of Wire. G. P. Clapp (Ir Age-Sept. 29.) 1200 w.

6932. Nomenclature of Asphaltic and Bituminous Products (E N-Sept. 29.) 600 w.

6941. The Amount of Dissolved Oxygen Contained in Waters of Ponds and Reservoirs at Different Depths. Thos. M. Drown (E N-Sept. 29.) 2800 w.

6957. Transmission of Heat Through the Walls of Buildings. V. Ill. Leicester Allen (Met W-Oct. 1.) 2000 w.

6958. Short History of Lake Navigation. II. C. H. Keep (M R C-Sept. 29.) 2000 w.

*6992. Aberration Problems. Ill. Dr. Oliver Lodge (N-Sept. 22.) 8000 w.

*7003. The Kelway System of Signalling. C. E. Kelway (El-Sept. 23.) 700 w.

*7009. The University College, Walker Engineering Laboratories, and the Scheme of Engineering Instruction. H. S. Hele-Shaw (I-Sept. 23.) 2000 w.

*7033. Aerial Navigation. Hiram S. Maxim (Inv-Sept. 24.) 900 w.

†7060. The Aërated Fuel Company's System of Burning Oil by Compressed Air. Ill. W. S. Collins (J F I-Oct.) 3200 w.

7086. Austrian Sheet and Mirror Glass. Ill. Julius Goldschmidt (M & B-Sept.) 1800 w.

7097. Oil Fuel. Ill. C. J. Maural (S E-Oct. 1.) 2500 w.

*7106. Is Modern Life Opposed to Artistic Development? Editorial (A R-July-Sept.) 6000 w.

7114. The Engineering Schools of the United States. XXIV. (E N-Oct. 6.) 2000 w.

*7117. Chemistry Incompetent to Determine the Hygienic Purity of Water. Geo. Troup Maxwell (A H-Oct.) 1000 w.

*7132. Shall We Ever Have a Seeing Machine? R. W. C. (D-Oct. 1.) 800 w.

7142. Modern Explosives. G. W. Wilkinson (C E-Oct.) 6000 w.

7143. The Ratio of Explosions in Gases. H. B. Dixon (C E-Oct.) 3000 w.

7154. Waterways Guide to the World's Fair. Ill. (M R C-Oct. 6.) 1700 w.

7155. Grain Elevator Equipment on the Lakes. Ill. (M R C-Oct. 6.) 1200 w.

7156. Short History of Lake Navigation. III. C. H. Keep (M R C-Oct. 6.) 600 w.

*7171. Advantages of Analytical Chemistry to Engineers. Henry Cherry (P Eng-Sept. 30.) 2500 w.

*7179. Aërial Navigation.—Letters from Edw. P. Frost, Arthur Williams, and "Navigable" (Inv-Oct. 1.) 1500 w.

*7181. New Discoveries in Spectroscopy. Ill. (Eng L-Sept. 30.) 800 w.

*7218. La Fibre Vulcanisée, ses Propriétés, et ses Principales Applications. Ill. Félix Beaujouan (G C-Sept. 17.) 1500 w.

*7226. Utilisation des Forces Naturelles. Les Moteurs Marins. Ill. VII. (Elec-Sept. 15.) 1350 w.

*7279. Steam Blast in Fuel Combustion. J. M. Whitham (E M-Oct.) 1000 w.

*7291. Tar as Fuel. T. Bower (J G L-Oct. 4.) 1000 w.

7303. The Engineering Schools of the United States. XXV. (E N-Oct. 13.) 2400 w.

†7329. Through the Amazon Rubber Country to Iquitos. J. Orton Kerbey (I R W-Oct. 15.) 2600 w.

7334. Short History of Lake Navigation. IV. C. H. Keep (M R C-Oct. 13.) 1400 w.

7348. An English Hot-Water Heating System. Ill. (Met W-Oct. 15.) 3500 w.

NEW BOOKS OF THE MONTH.

[For the convenience of readers any American books will be supplied at publishers' prices by The Engineering Magazine Co. Foreign books, 25 per cent. extra.]

Air Compressors, Duplex and Single, Actuated by Steam, Belt, Gearing, or Water Power. New York: Clayton Air Compressor Works. [4to, paper, 92 p., sent free on application.]

Ardant, F.=Le Papier, son Histoire, sa Fabrication Ancienne et Moderne. Limoges: Libr. Ve. Ducourtieux. [8vo, paper, 38 p.]

Automari, X.=Leçons de Cinématique et de Dynamique, Suivies de la Détermination des Centres de Gravité. Paris: Nony et Cie. [8vo, 236 p.]

Catalogue of Woodworking Machinery. Illustrated. Prefaced by a Telegraph Code for the Use of Correspondents. Cincinnati: The Egan Co. [Nearly 300 p., sent free on application.]

Coëtlogon, G. de=Le Tannage Electrique. Paris: Lib. Michelet [8vo, paper, 24 p.]

Dion, A. de=Introduction de l'Architecture Gothique en Italie par les Cisterciens Français. Caen: Lib. Delesques. [8vo, paper, 35 p.]

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MACHINE-SHOP NOTES.

Conducted by Albert D. Pentz.

THE question of mechanical apprenticeship is worrying many worthy people,—unnecessarily, for there is no dearth of good mechanics, either in America or elsewhere. This state of facts is not denied, however, by those who most concern themselves about the case, but still they fret because mechanics are mostly of foreign birth and these foreigners will not permit an American boy to learn a trade. They should state the whole truth, and that is that these workmen do not want boys of any nationality, American or otherwise. There is no trade in the country that is not more or less overcrowded, and for every vacancy there are many applicants. This condition results of course in destructive competition that affects wages unfavorably. Then why this solicitude for the American boy? Are we anxious to put our sons into trades that already are more than full, where they will be obliged to compete with European mechanics accustomed to habits of life less expensive than the standard which has been established in this country? The reason that the mechanical trades are overcrowded by foreigners is not that American boys are excluded from apprenticeship, but because these foreigners are frantically invited to our shores, enthusiastically welcomed, and, when they arrive, are given work in preference to Americans because they work for less money. That is the whole situation.

A PECULIARITY in the labor agitation which no one has appeared to notice is that no matter how many workmen we may absorb from Europe, no matter how many go to Australia, Asia, or Africa, or into the European armies, there is no complaint that any country is suffering from lack of hands skilled to do its mechanical work. On the contrary, there are always "hordes of underpaid and underfed paupers" still there to compete with us. Is there really any country where on the whole there is a demand for mechanical laborers that is not more than met by the supply?

THE end thrust given to a spindle by a milling-cutter having spiral teeth is very great, and it has a serious disturbing effect on the bearing of the spindle. The spiral arrangement of milling-teeth, however, is the best one known to produce a smooth surface and to obviate the succession of blows on the work due to teeth cut parallel with the center of the arbor and placed at right angle with the feed. In a study of means to overcome this objectionable end thrust, three suggestions present themselves. The first is to place the work platen slide at such an angle to the cutter-spindle as to neutralize the angle of the spiral on the cutter, and thus meet one thrust with an equal counter thrust. The objections are that the cutter would need to be longer and that the cut would consume relatively more time. Another suggestion is to make the cutter the frustrum of a cone having an inclination with its center equal to the angle of the spiral, and thus oppose two thrusts that are equal. This really would take a shorter cutter than a cylindrical one, and not be a difficult one to make with modern tools; neither would the cut be materially lengthened. All tool-makers, again, know that angular milling-cutters produce very satisfactory surfaces. The other suggestion is to make cylindrical cutters of two parts, one part to be a right-hand spiral and the other a left-hand spiral. The ends of each tooth on cutters of the same sizes in pairs should clutch each other wherever they abut, so as to break joints and prevent a ridge on the work. This may be done either by cutting away $\frac{1}{16}$ inch from the end of each alternate tooth on both cutters, or by cut-

ting as much out of each tooth on one end as will admit one half of one tooth on the other half cutter. An overhang usually is turned for this clutch in making the cutter blank. It is not material whether the spiral retreats toward the middle or away from it.

ONE of the things that Jack Swifter learned from the new toolmaker is that many of the holes in a drill jig may be transferred in a drill press directly from a correct model much better and more quickly than they can be laid out and bored on a lathe, or anywhere else. The trick is a very simple one, but it is surprising how few toolmakers have mastered it. When the body of the jig has progressed so far that its seat and stops are finished and it will receive the model or similar stock part and properly position, locate, and fasten it, and when also its supports or feet are made so that it will set on the table of a drill press properly, the model is fastened into it by temporary clamps in such a manner as to expose on its free sides the open ends of all the holes possible. Then with suitable drills, properly provided with sleeves to protect the holes in the model, all these holes are located to a depth slightly greater than the lips of the drill into the body of the jig. It frequently happens, however, that holes cannot be located thus, their positions being such as to forbid the introduction of a drill from their back ends; for instance, the hole may not be drilled entirely through the model. In such cases the clearance hole is laid out with an approximation to correctness and made with an ordinary drill. When all the holes are located by one or another method, they are drilled through the jig by drills somewhat larger than the model holes, the model being removed to permit this. Then the model is returned to its seat with superlative attention to cleanness, position, and fastenings, and the jig is placed on a drill press which has its table square with its spindle. Then with counter bores having stems or "tits" long enough to extend all the way through the clearance holes that have been drilled in the body of the jig and well into the model before the cutting lips can come down to the jig,—which "tits" must fit the holes in the model quite snugly,—the holes from the model to the body are bored to the required sizes very carefully. Care must be had to place the holes in operation exactly in alignment with the drilling spindle.

THE value of mechanical dogmatism may be indicated thus: If an ordinary drill, such as is used for iron and steel, were now made for the first time, and not experimentally tried but examined instead by a theorist for efficiency, the verdict certainly would be that it could not possibly bore into metal unless it could follow a hole previously made, as large as its point, and that it could not be located in one position long enough to center it for drilling a hole. The point of a drill is a solid angle, about 120 degrees in modern practice, and usually, at its best, is no shorter on its edge than one-tenth of the diameter of the drill. This blunt angle in drilling must grub or push its way into the solid metal under the most unmechanical of circumstances and within conditions unlike those of any other mechanical operation. Looking at it as a chisel, the angle of 120 degrees is a very blunt one, and as such has but very small penetrating power. Looking at it again as a cutting or scraping tool, the angle of 30 degrees rise for a cutting edge is absurd. The combined effect, however, in a drill of this edge simultaneously penetrating by pressure and cutting by revolution is so satisfactory as neither to give occasion for complaint nor to demand a more efficient substitute.

I HAVE found it possible to make a very perfect plane of hardened steel, and also to make a ball that is a satisfactorily perfect sphere of the same material, which ball was designed to roll without resistance on the plane. But it will not roll without resistance, and every time that resistance is an atom of dust. I find it to be absolutely impossible to get and keep so small a face as a half-inch square perfectly clean one instant of time in any place where it is possible to experiment upon it.

COMMENT & CRITICISM.

The Cause of the Homestead Troubles.

MR. JULIAN HAWTHORNE discusses the Homestead strike and its remedy with signal ability in the September issue of THE ENGINEERING MAGAZINE. Something remains to be said, however, as to the strike and its remedy, and some statements of Mr. Hawthorne should be revised. As pointed out by Mr. Hawthorne, the employment of Pinkerton guards "to get possession of their mills, and to safeguard their new laborers," is the one error of the Carnegie management. Leaving out the question of error, this states the matter exactly, but so concisely as to minimize perhaps the most important fact in this whole affair.

Three years before the Homestead strikes, the Carnegie company had a labor strike at Homestead in which the men proceeded to violence, disorder, and bloodshed, when the Sheriff of Allegheny county proved to be so absolutely powerless that the firm were compelled to concede to the demands of the men to escape disorders which they were not prepared to cope with, and against which they could not get protection from the law. The firm also knew the deadly hatred with which non-union workers of iron and steel are regarded by the members of the Amalgamated Association, and as they had, prior to the strike, engaged some 700 of the general mechanical force at Homestead (non-union workmen) and purposed running the mill as "non-union," should the Amalgamated Association not accept the terms offered, the employment of Pinkerton guards to protect their new employés from the murderous Amalgamated Association assumes a new meaning. So far from being an "error," it was an unquestionable duty under the circumstances. There was no hope of otherwise protecting non-union men in the Homestead mill. The landing of Pinkertons at Homestead was defeated by the unexampled violence and ferocity of the strikers, but the motive for their employment was certainly correct.

During the last few years the market price of steel billets, the crude product of the Homestead mills, declined through competition from $36 to $22.25 per ton. All the resources of human ingenuity and investment of capital had been employed by the firm to enable them to meet the growing competition without reducing wages. As a matter of fact the operation of the improved machinery and the tonnage scale had actually increased the wages of many men to an absurd degree. The necessity for reducing the cost of billets was imperative, and while reducing the rate of wages per ton, the Carnegie concern, by introducing still more improved and more powerful machinery, had provided for maintaining the daily or weekly earnings of their men while reducing the scale per ton. Therefore, the struggle of the men at Homestead, so far as wages are concerned, was to secure to themselves the advantage of the improved machinery just introduced, rather than to avoid a reduction in their daily earnings. This, however, has been abandoned, and the only contention of the men now is for the recognition of the Amalgamated Association as an organization in the Homestead mill. But this is impossible, as the Amalgamated Association in Homestead is so steeped in crime—nearly one-half of all their men being at present under indictment by the Grand Jury for various offenses up to riot and murder—that no self-respecting employer could consent for a moment to treat with the Association on any terms.

Whatever abuses may exist concerning the distribution and tenure of land, the remedy for "Homestead" and similar disorders does not lie in that direction. The iron, steel, and similar workers accustomed

to live gregariously do not wish to go upon the land as agricultural workers and would not occupy it as a gift.

The remedy for "Homestead" is to be found in the study of the causes that produced "Homestead" or similar disorders, —namely, immigration. For many years we have received the scum of Europe in countless numbers, and now have commenced upon the scum of Asia (cholera included). We have emptied the prisons and poorhouses of Europe and are attempting to assimilate the most inconceiveably heterogeneous mass into our civilization all at once. We have bitten off much more than we can chew, not to speak of assimilating, until the labor market is congested and the conditions of employment are beginning to approximate those of other overcrowded countries. The only remedy for "Homestead" is the absolute cessation of immigration, or putting immigration under such restrictions as to exclude all but the most desirable; then competition will fix wages in America at such figures as to put an end to "Homestead" and similar disgraceful exhibitions.

H. E. COLLINS.

Pittsburgh, September 30, 1892.

A Last Word from Mr. Shriver.

YOU would doubtless not care to give space to a prolonged controversy over the New York Dock question, and I have no desire to continue it while Mr. Black remains in his present temper on the subject. But I would like to call the attention of your readers to his argument based on the assessed value of Brooklyn and New York water-front properties. He does not seem to remember that assessments are by no means conclusive evidence as to true values. I could show him a lot that I tried to buy not long ago at $11,500 when it was assessed at $3500. Moreover, the Brooklyn assessment is supposed to include the value of the warehouse buildings, while the New York assessment is levied only on the sheds (which are found most useful) in addition to the land which they cover,—quite an essential factor of variation.

As Mr. Black has drawn in somewhat violently the principle of the Single Tax, I may add that, while I most certainly have no desire to disclaim my belief in it, I do not think the movement needs any defense by me from attack at his hands. Further than this, the objection which I raised to his scheme was not based on anything economically deeper than a personal knowledge of commercial needs.

E. J. SHRIVER.

New York, September 23, 1892.

A Fatal Admission, If Allowed.

THERE is no surer way to make the human race a tribe of fools than to protect it from the consequences of folly. Such, in brief, is the attitude taken by Professor N. S. Shaler in THE ENGINEERING MAGAZINE toward the legal regulation of the professions; and with the general considerations which he adduces in support of this position no man can be more in sympathy than I. But in his exception of the doctors from his general rule, I fear he has given the architects and many other professional men a chance to claim the shelter of legal privilege. It is necessary therefore to point out the weakness of his reasons for according special favor to the medical men.

"The man," he says, "who is taken suddenly ill or who has met with an injury is not in a position to form judgment based on reasonable inquiry as to the professional education of the medical man from whom he seeks help."

I answer that, if such accident befalls a man at his home, or so near his home that he can at once be taken there, his family will send for that physician whom he, when sound in mind and body, determined, after reasonable inquiry, to employ in such an emergency. A man, when sick, is entitled to the benefit of the judgment which he formed when well. To deprive him of it is not only to interfere with his liberty, but to take a cruel advantage of his helplessness. If, however, the supposed accident befalls him at a distance from home and friends, and his condition is such as to prevent him from deciding for himself, there is nothing to hinder the selection, by the authorities or others taking him in

charge, of a physician possessing a diploma from the faculty of a high-class medical college, which ought to be rather more reliable than the certificate of a State board of examiners probably owing their positions to their views of the tariff question or some other problem even less closely related to the practice of medicine. There is nothing, then, in the suddenness or other peculiar circumstances of this hypothetical patient's illness, to justify, much less necessitate, even in his own behalf, a denial of the liberty of healing. But even if one exceptional patient were placed in greater danger by the absence of a system of State licensing, must we, to protect him, abridge the liberty of a hundred ordinary patients? For my own part, the little confidence that I have in medical science in its present state is reposed in the Allopathic representatives thereof, but I cannot see that the remote liability to which I am exposed of being treated by a clairvoyant if taken suddenly ill among Spiritualists should deprive Alfred Russell Wallace, an eminent man of science, who, as a Spiritualist, possibly believes in the clairvoyant physician, of the right to summon the unlicensed doctor of his choice when he falls ill.

But, urges Professor Shaler, the sick or injured man, by his error of judgment, endangers not only his property but his life. Precisely; and so does the man who enters the building planned by an incompetent architect. It is much truer of such a man than of a sick person that he "is not in a position to form judgment based on reasonable inquiry as to the education" of the professional man to whom for the moment he entrusts his life. If danger of this character is sufficient to warrant monopoly in medicine, all the more then does it warrant monopoly in architecture. But in truth it warrants neither. It is a minor consideration sinking out of sight in comparison with the wider and deeper dangers involved, as Professor Shaler shows, in relieving men of the responsibility of choice, depriving them of the advantages of competition, and weakening the incentive to innovation and progress.

It is especially strange that Professor Shaler should single out the profession of medicine for exemption from rivalry, when he admits that valuable contributions to the healing art "have come from men absolutely without schooling," "Presnitz, the founder of modern hydropathy," he says, "was an illiterate peasant, yet he invented methods of treatment which have been found most valuable, and which, to a great extent, have been adopted by the medical profession." Now mark the sentence which immediately follows: "The foregoing considerations seem to lead to the conclusion that any efforts to support our learned professions (*except medicine*) by a system of government licenses will go against the spirit of our society." The parenthetical qualification which I italicize constitutes in such a connection the most glaring *non sequitur* that a man with so logical and philosophical a mind ever permitted to escape its vigilant scrutiny.

Professor Shaler's first ground of privilege for the doctors being inadequate, and his second ground being illogical, it remains only to consider his third ground, which we shall find to be impertinent. "So far as the practice of medicine is concerned," he declares, "the argument in favor of legal control seems to have sufficient popular support at present to justify a certain departure from the principle which dictates freedom of contract as the basis of relation between employer and employed, in all the walks of life." I submit that such a sentence is entirely out of place in a serious discussion of a question of political ethics. Certainly no one needs to be told that the will of the majority *necessitates* the adoption of whatever possible policy it may favor, but to be told that it *justifies* it knocks the bottom out of all philosophy. I take it that Professor Shaler, in asking the question: "Shall the Professions be Regulated?" did not intend to inquire whether fifty-one men out of every hundred favor such regulation, but whether, if such is the fact, they are wise in favoring it; and that the object of his paper was to convince at least two of the fifty-one that they are unwise. How absurd, then, to defeat himself by telling the fifty-one that they are justified simply because they are fifty-one. Of course it follows

that the architects and their friends—or, for that matter, the hod-carriers and their friends—have only to become fifty-one to be entitled to a monopoly. *Quod* NON *erat demonstrandum.*

I offer these criticisms simply because I am in hearty accord with Professor Shaler's main position, and therefore desire to anticipate those friends of monopoly and despotism who are sure otherwise to successfully assail this champion of liberty at his only vulnerable point.

A CONSISTENT LIBERTARIAN.

Inventors in Place of Poets.

THE expressions of despair as to the future of poetry in the English language which the recent deaths of certain masters of the art have called forth, the advanced age of all the famous poets who are now alive, and the opinion, freely stated, that poets no longer are born to highly-civilized races, lead to the following observations of cause and effect.

While callow genius starves as orthodoxly in this cultured age as at any prior period of comparative barbarity, it has transferred and diverted its creative efforts from the writing of poetry to the invention of devices designed to improve the mechanic arts. And when a genius becomes either an inventor or a poet, it is as an inventor or a poet that he lives or dies.

That the mind which invents and constructs in mechanics is superior to that which makes good verse is not a necessary corollary. Rather do environment and the tendencies of local or class culture start the poet to write or the inventor to construct. And that a person is an inventor and not a poet merely argues that his early associations were industrially located and within virile rather than among effeminate influences.

The English-speaking race being industrial in its present tendency, its genius takes the industrial trend, and as a consequence develops fewer poets and tamer ones, but more inventors and fiercer ones. He who aforetime indited a sonnet to his lady's eyebrow would now devise a corset and be proud of the invention. While the spirit of the age would recognize more grace, beauty, and expression in that invention, properly used, than in a dozen sonnets.

The causes that impel a genius to consecrate his life to invention are the same causes which forced his barbaric predecessor to devote his energies to poesy and which now, in less favored lands, still drive the gifted in this latter direction.

The prime reason why a man of genius begins to write poetry at all, or begins to invent mechanical appliances at all, is that he is dissatisfied. The irksome quality of labor begets a desire to evade it. The crude impression that fortune and fame await impatiently the productions of genius furnishes an objective. The consciousness of callow capability creates a confidence to which the brake of experience has not as yet been applied; so the ambitious first creation is essayed, and fails. Experience is not an attribute of genius. It is the legitimate child of long and hard labor.

Neither powerful engines nor epics are created by mental hocus pocus, but into each must go experience, care, and judgment. Each of these must, at least, be equal to the inspiration if the creation is to be successful and famous.

Creative work is always a manifestation of the ambition to achieve the maximum of effect through the minimum of effort. This ambition is the spirit of the modern arts, and whether such creative work be the succinct statement of a truth in poetry, or the invention of a labor-saving machine, it tends to satisfy this ambition.

A mechanical truth, however, is a demonstrated truth, while the poetic truths are but statements of apparent truths and compare only with the drawing from which a machine is to be made. Thus the product from the inventor differs from the product from the poet only in degree, or as practice differs from a sound theory.

A mechanical enthusiast sees the same beauties in motion as the poetic devotee finds in verse. Perfect rhythm, admirable harmony, grace, and expression, combined with the added excellence of utility.

A. D. PENTZ.

Elizabeth, N. J.